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(71)出願人　000176213
三信工業株式会社
静岡県浜松市新橋町1400番地

(71)出願人　000010076
ヤマハ発動機株式会社
静岡県磐田市新貝2500番地

(72)発明者　原田　博
静岡県浜松市新橋町1400番地　三信工業株式会社内

(74)代理人　100066452
弁理士　八木田　茂　（外１名）

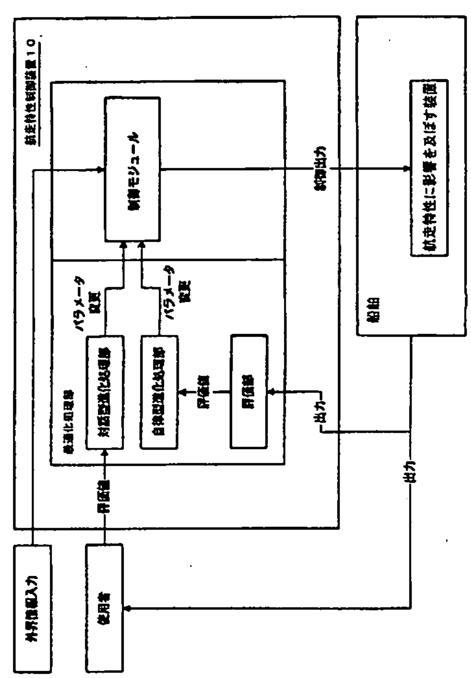
最終頁に続く

(54)【発明の名称】　航走特性制御装置

(57)【要約】

【課題】　従来の問題点を解決し、使用者の好みや使用環境等に応じて最適な航走を可能にする航走特性制御装置を提供すること。

【解決手段】　本発明に係る航走特性制御装置は、航走特性に影響を及ぼす装置を備えた船舶において、所定の入力情報に基づいて前記航走特性に影響を及ぼす装置の操作量に関する出力を決定する制御モジュールを備えた航走特性制御装置を設け、前記航走特性制御装置に、船舶としての特性を評価対象として、実時間で、前記制御モジュールを最適化する最適化処理部を設けたことを特徴とする。



【特許請求の範囲】

【請求項１】航走特性に影響を及ぼす装置を備えた船舶において、
所定の入力情報に基づいて前記航走特性に影響を及ぼす装置の操作量に関する出力を決定する制御モジュールを備えた航走特性制御装置を設け、
前記航走特性制御装置に、船舶としての特性を評価対象として、実時間で、前記制御モジュールを最適化する最適化処理部を設けたことを特徴とする航走特性制御装置。

【請求項２】前記航走特性に影響を及ぼす装置が、原動機を備えた船外機を含み、
前記航走特性制御装置が、前記原動機の動作特性を制御する制御装置であることを特徴とする請求項１に記載の航走特性制御装置。

【請求項３】前記原動機が、電子スロットル装置及び／又は電子制御燃料噴射装置を備え、
前記制御装置が、電子スロットル弁開度及び／又は燃料噴射量を制御することを特徴とする請求項２に記載の航走特性制御装置。

【請求項４】前記航走特性に影響を及ぼす装置が、トリム装置を備えた船外機を含み、
前記航走特性制御装置が、前記トリム装置のトリム角度を制御する制御装置であることを特徴とする請求項１～３の何れか一項に記載の航走特性制御装置。

【請求項５】前記航走特性に影響を及ぼす装置が、艇内に設けられる原動機を含み、
前記航走特性制御装置が、前記原動機の動作特性を制御する制御装置であることを特徴とする請求項１に記載の航走特性制御装置。

【請求項６】前記原動機が、電子スロットル装置及び／又は電子制御燃料噴射装置を備え、
前記制御装置が、電子スロットル弁開度及び／又は燃料噴射量を制御することを特徴とする請求項５に記載の航走特性制御装置。

【請求項７】前記航走特性に影響を及ぼす装置が、艇体に取り付けられる可動式フラップ装置を含み、
前記航走特性制御装置が、少なくとも可動式フラップ装置の動作特性を制御する制御装置であることを特徴とする請求項１～６の何れか一項に記載の航走特性制御装置。

【請求項８】前記原動機が、推進力を発生させるための水流を発生させるための原動機であり、
前記航走特性に影響を及ぼす装置が、前記水流の向きを変更可能なウォータノズルトリム装置を含み、
前記航走特性制御装置が、少なくとも前記ウォータノズルトリム装置の動作特性を制御する制御装置であることを特徴とする請求項５～８の何れか一項に記載の航走特性制御装置。

【請求項９】前記航走特性制御装置における制御モジュールが前記航走特性に影響を及ぼす装置の操作量を出力し、
最適化処理部が、前記制御モジュールの制御パラメータを最適化するように構成されていることを特徴とする請求項１～７の何れか一項に記載の航走特性制御装置。

【請求項１０】前記航走特性制御装置における制御モジュールが、所定の入力情報に基づいて前記航走特性に影響を及ぼす装置の操作量を出力する基本制御モジュールと、
所定の入力情報に基づいて前記操作量に対する補正量又は補正率を出力するを備え補正用制御モジュールとを備え、
前記最適化処理部が、前記補正用制御モジュールの制御パラメータを最適化するように構成されていることを特徴とする請求項１～７の何れか一項に記載の航走特性制御装置。

【請求項１１】前記最適化処理部が、
最適化手法に関する演算を行う最適化演算部と、
予め設定された評価基準に基づいて最適化処理に関する評価を行う自律型評価部を備えていることを特徴とする請求項１～１０の何れか一項に記載の航走特性制御装置。

【請求項１２】前記最適化処理部が、
最適化手法に関する演算を行う最適化演算部と、
最適化処理に関する使用者意思に基づく評価を入力する手段とを備え、
前記使用者意思に基づく評価に沿って最適化を行うことを特徴とする請求項１～１０の何れか一項に記載の航走特性制御装置。

【請求項１３】前記所定の入力情報が、少なくとも艇速、艇加速、艇角、操舵角、スロットル操作量又はエンジン回転数の何れかを含むことを特徴とする請求項９～１２の何れか一項に記載の航走特性制御装置。

【請求項１４】前記評価対象となる船舶としての特性が、少なくとも燃料消費率及び／又は消費電力を含むことを特徴とする請求項１～１３の何れか一項に記載の航走特性制御装置。

【請求項１５】前記評価対象となる船舶としての特性が、少なくとも停船時から最高速度に達するまでの時間及び／又は使用者の指定した艇速に対する定速航走制御の追従性を含むことを特徴とする請求項１～１４の何れか一項に記載の航走特性制御装置。

【請求項１６】前記評価対象となる船舶としての特性が、少なくとも船舶の乗り心地であることを特徴とする請求項１～１５の何れか一項に記載の航走特性制御装置。

【請求項１７】前記最適化評価部が、ヒューリスティックを用いて最適化に関する演算を行うように構成されていることを特徴とする請求項１～１６の何れか一項に記載の航走特性制御装置。

【請求項１８】前記ヒューリスティックが進化型計算法であることを特徴とする請求項１７に記載の航走特性制御装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、使用者の好みや使用環境等に応じて最適な航走を可能にする航走特性制御装置に関する。

【０００２】

【従来の技術】従来から、艇体の後部に取り付けられて使用される船外機は、出荷前に艇体に取り付けた状態で試走して、そのエンジンやトリム装置の特性のセッティングが行われている。

【０００３】

【発明が解決しようとする課題】しかし、通常、船舶は、天候や季節の変化により使用環境が著しく変動し、また、使用者の好みも著しく変動するものなので、全ての使用者があらゆる使用環境下において満足できる航走特性が得られるように船外機のエンジン及びトリム装置をセッティングするのは困難である。このため、船舶を実際に使用するときには、セッティングの時と積載状態が異なり、また、波などの外乱も受けるので、セッティング時と使用環境が著しく異なることが多いため試走の段階でセッティングされた特性が必ずしも最適なものであるとは限らず、場合によっては、使用者に乗り心地が悪いと感じられることもある。このような問題点は、船外機を搭載するタイプの船舶に限らず、艇内に原動機を搭載した船舶や、可動式フラップ装置を取り付けた船舶にも共通している。本発明は、上記した従来の問題点を解決し、使用者の好みや使用環境等に応じて最適な航走を可能にする航走特性制御装置を提供することを目的としている。

【０００４】

【課題を解決するための手段】上記した目的を達成するために、本発明に係る航走特性制御装置は、航走特性に影響を及ぼす装置を備えた船舶において、所定の入力情報に基づいて前記航走特性に影響を及ぼす装置の操作量に関する出力を決定する制御モジュールを備えた航走特性制御装置を設け、前記航走特性制御装置に、船舶としての特性を評価対象として、実時間で、前記制御モジュールを最適化する最適化処理部を設けたことを特徴とするものである。

【０００５】

【発明の実施の形態】以下、添付図面に示した幾つかの実施例を参照しながら本発明に係る航走特性制御装置の実施の形態について説明する。図１は、本発明に係る航走制御装置の一実施例を示す概略ブロック図である。図面に示すように、この航走制御装置は、適当な外界情報を入力情報とし、その入力情報に基づいて、航走特性に影響を及ぼす装置の操作量に関する情報を決定し、出力

する制御モジュールを備えている。この制御モジュールは、好ましくは、ファジィ推論システムを採用している制御モジュール、例えば、ファジィ制御器、ファジィ意志決定システム又はファジィニューロ制御器であり得るが、これに限定されるものではない。また、この航走制御装置は、最適化処理部を備え、この最適化処理部は、対話型進化処理部及び／又は自律型進化処理部を有し、これらの進化処理部により船舶としての特性を評価対象として、実時間で、前記制御モジュールのパラメータを最適化する。最適化されるべきパラメータは、制御モジュールに関するパラメータであれば任意のパラメータでよく、例えば、ファジィ推論システムを採用している場合には、メンバシップ関数の数、形状、位置及び広がりを決めるためのパラメータ、ファジィルール、又は入出力値の規格化係数等が挙げられる。また、最適化のための評価については、対話型進化処理部に対しては使用者が直接行い、また、自律型評価処理部に対しては予め所定の評価基準に基づいて設計された評価部によって行われる。このように、船舶としての特性を評価対象として、実時間で、航走特性に影響を及ぼす装置の動作特性を最適化できるように構成することで、船舶の特性を使用者の好みや使用環境に実時間で適合させることが可能になる。

【０００６】次に、本発明に係る航走特性制御装置の適用例を制御対象を特定した実施例を挙げて説明していく。図２～図１７は、本発明に係る最適化方法を滑走艇の船外機及びトリム装置に適用した実施例を示している。図２は、船外機及びトリム装置と制御装置との関係を示す概略図である。図中、符号１０は制御装置を示しており、この制御装置１０は、艇体の変化や外乱に応じた定速航送制御及び加速最適化制御を実現する最適な操船特性及び加速特性を獲得し、また、使用者の好み、即ち、使用者が異なる場合は勿論のこと、同一の使用者の好みの時間的変化、例えば、春と秋で操船の好みが変化するような場合に応じても最適な操船特性及び加速特性を獲得するように構成されている。なお、本実施例において、「操船特性」とは、電子スロットル弁操作とトリム操作による船速制御特性のことを意味する。制御装置１０は、エンジン回転数、速度、加速度、ステアリング角度、スロットル開度等の情報を入力し、これらの入力情報に基づいて電子スロットル弁と、油圧シリンダ及び油圧ポンプを備えたトリム装置とを操作することにより、吸入空気量及び船体の姿勢を制御し、定速航走制御及び加速最適化制御を行う。

【０００７】図３及び図４は、制御装置１０の内部構成を示す概略ブロック図である。図面に示すように、この制御装置１０は定速航走制御部及び加速最適化制御部を有する。定速航走制御部は、図３に示すように、所定の入力情報に基づいて電子スロットル弁の開度とトリム角度を決定する操船ファジィ制御モジュールと、前記操船

ファジィ制御モジュールの規格化係数を最適化する自律型進化処理部と、自律型進化処理部の評価を行う操船性評価部と、前記操船ファジィ制御モジュールのファジィルールを最適化する対話型進化部とを有する。また、加速最適化制御部は、図４に示すように、所定の入力情報に基づいてトリム角度を決定するトリム制御モジュールと、前記トリム制御モジュールの制御パラメータを最適化する自律型進化処理部と、自律型進化処理部の評価を行う加速性評価部と、前記トリム制御モジュールの制御パラメータを最適化する対話型進化処理部とを有する。尚、前記「規格化係数」とは、入出力情報の大きさを調整する係数を意味する。

【０００８】１．定速航走制御部における制御：操船ファジィ制御モジュールは、ファジィ推論システムとして、例えば、簡略推論法を採用しており、エンジン回転数、速度、加速度、ステアリング角度に対する電子スロットル弁開度変化量とトリム角度変化量とを出力する。前記ファジィルールテーブルは、熟練者の操船知識を基に設計され得、簡略推論法におけるファジィルールは実数値で表される。定速航走制御部における自律型進化処理部は、例えば、遺伝的アルゴリズムを採用しており、図５に示すように前記操船ファジィ制御モジュールの規格化係数をコード化して個体を生成し、遺伝的アルゴリズムを用いて、これらの規格化係数の最適化を行う。自律型進化処理中の各個体の評価は、目標となる操船特性、例えば、使用者が定めた速度に対する実速度の偏差が目標値以下に近づくほど評価値が高くなるように設定された評価部が行うように構成されており、その結果、操船ファジィ制御モジュールの規格化係数は目標となる操船特性に向けて自動的に最適化され、使用環境や艇体が変化した場合においても、最適な操船特性が得られるようになる。このように、進化処理における評価を、予め設計された評価部により行い、最適化を自動的に行えるようにする方法を本明細書では自律型評価を称する。また、操船制御部における対話型進化処理部は、例えば、遺伝的アルゴリズムを採用しており、図６に示すように前記操船ファジィ制御モジュールのファジィルールテーブルの一部をコード化して個体を生成し、遺伝的アルゴリズムを用いて、これらのファジィルールテーブルの一部の最適化を行う。対話型最適化処理中の各個体の評価は、使用者が実際に体感する乗り心地に基づいて行うように構成されており、その結果、操船ファジィ制御モジュールのファジィルールテーブルの一部は使用者の評価に従って最適化され、使用者の評価に合った最適な操船特性が得られるようになる。このように、進化処理における評価を使用者が行う方法を本明細書では対話型評価と称する。次に、上記した定速航走制御部における進化処理について説明していく。図７は、定速航走制御部の進化処理の流れを示すフローチャートである。上述のように、この制御装置では、進化処理を行う際に、定速航走制御部の自律型進化処理部については自律型評価を行い、対話型進化処理部については対話型評価を用いている。評価方法が異なると最適化処理の流れが異なるので、以下の説明では自律型評価方法を採用した進化処理と対話型評価方法を採用した進化処理とを分けて説明する。

ａ．自律型進化処理部における進化処理

図７に示すように、始めに規格化係数の初期値を予め決めた範囲内でランダムに決定し、複数の初期個体からなる第１世代を生成する（ステップ１－１）。そして、第１世代の全ての個体に対する定速航走制御評価を行う（ステップ１－２）。ここで、定速航走制御評価について簡単に説明すると、時分割により複数の個体を擬似的に並行に動作させ、その期間の合計での評価値を比較する。具体的には、エンジン回転数の使用域に応じて評価を変更し、例えば、エンジンの低回転域を用いるトローリングの場合には、図８に示すように、１０個の個体について、１分ずつ制御を行い、目標速度に対する実速度の差の絶対値をサンプリングタイム毎に合計し、これを１サイクルとして２０サイクル繰り返し、評価期間内の総合計を評価値として算出する。こうすることで、気象や海象（具体的には、例えば、風や波）等の外乱による影響を、各個体でトータルとして揃えられるため、各個体の特性を公平に評価することができる。また、エンジンの高回転域を用いるクルージングの場合、前記した評価方法に加えて、高速時に発生する不安定な挙動、即ち、艇体が上下に揺れるピッチングや、左右に振られるダッチロールを抑制するために、ピッチング、又はダッチロールを検出した場合には、個体の評価値として０を与え、トリム角をピッチング、又はダッチロールが発生しない角度まで減少させることで艇体を安定させ、以降その角度を最大トリム角として各個体の評価を行う。こうすることで、高速時に不安定な挙動が発生することを防止することができる。上記した評価値計算処理（ステップ１－２）で得られた各個体の評価値に基づいて、それが最適な操船特性か否かを評価し（ステップ１－３）、評価の結果、最適な操船特性が獲得できたか否かを判断する（ステップ１－４）。そして、最適な操船特性が得られていた場合には進化処理を終了し、得られていない場合には、進化型計算モジュールに入り、次世代の個体群を生成する（ステップ１－５）。

ｂ．対話型進化処理部における進化処理

図７に示すように、対話型進化処理部には通常制御モードと進化モードとがある。通常制御モードと進化モードの切り換え（ステップ２－１）は、予め決められた条件、例えば、時間に基づいて行ってもよく、また、図９に示すようなインターフェイスを介して使用者の意志に基づいて行ってもよい。通常制御モードでは、その時点で確定しているファジィルールテーブルを用いてファジィ制御を行い、同時に進化モードに切り替わるまでの各

ファジィルールの適合度の累計を求める（ステップ２－２）。具体的には、図１０に示すように、ある時刻における各ファジィルールの適合度を演算する適合度テーブルの演算結果を、進化モードに切り替わるまでの適合度の累計を演算する累計テーブルに加算し（ステップ２－３）、これを進化モードに切り替わった時点で終了する。進化モードに切り替わると、図７に示すように、累計テーブルを参照して、対応する任意の数のファジィルールを、累計の大きいものから順に染色体にコード化し（ステップ２－４）、これを初期値として正規分布に従った摂動を加え、複数の初期個体から成る第１世代を生成する（ステップ２－５）。そして、第１世代のいずれかの個体のパラメータを用いて試乗を行い（ステップ２－６）、その個体に対する評価値を使用者が入力する（ステップ２－７）。前記評価値に基づいて、好みの操船特性が得られたか否かを判断し（ステップ２－８）、得られたと判断した場合には、その個体を最優良個体として進化処理を終了し、得られていない場合には、１世代の全ての個体に対して試乗及び評価が終了しかた否かを判断する（ステップ２－９）。全ての個体及び評価が終了していない場合には、ファジィ制御モジュールのファジィルールを別の個体のものに変更し（ステップ２－１０）、再び試乗を行わせる（ステップ２－６）。また、全ての個体に対する試乗及び評価が終了した場合には、規定世代数に達したか否かを判断し（ステップ２－１１）、達したと判断した場合には、その世代で最も評価値の高い個体を最優良個体として進化処理を終了し、達していないと判断した場合には進化型計算モジュールに入り（ステップ２－１２）、次世代の個体郡を生成し、再び、それらの個体のファジィルールを用いた試乗及び評価を行う。以上の処理は、好みの操船特性が得られるか、規定世代数に達するまで繰り返し行われ、その結果、操船ファジィ制御モジュールのファジィルールテーブルの一部は得られた個体のファジィルールに置き換えられ、累計テーブルは０に初期化される（ステップ２－１３）。その後、再び、通常制御モードに切り替わると、置き換えられたファジィルールテーブルを用いてファジィ制御を行い、進化モードに切り替わるまで、この時の各ファジィルールの適合度の累計を求める。上記した処理を繰り返すことによって、適合度の累計の高い、即ち、現在の環境においてよく使用される領域のファジィルールについて、集中して最適化を行うことが可能となり、また、あまり使用されていない領域のファジィルールを変更することがないため、環境が急変し、あまり使用されていない領域のファジィルールが使用された場合でも、安定した制御を行うことが可能になる。

【０００９】２．加速最適化制御部における制御

トリム制御モジュールは、速度に対するトリム変化量を出力する。図１１は、船舶の速度一抵抗曲線とトリム位置との関係を示すグラフである。図１１に示すように、

船舶の速度一抵抗曲線はトリム位置によって大きく異なる。艇体と水面との間に発生する抵抗は、大きく造波抵抗と摩擦抵抗とに分けることができる。造波抵抗とは、船舶の推進時に自らが発生する波による抵抗であり、摩擦抵抗とは艇体と水面との摩擦によって発生する抵抗である。低速域では、増速するに従って造波抵抗が増加し、ある速度において極限となる。この状態はハンプと呼ばれ、ハンプは、トリム角が最も小さな状態であるフルトリムイン」の時に最も小さく、トリム角が最も大きな状態であるフルトリムアウトに近づくにつれて次第に大きくなる。ハンプを超えると、造波抵抗は次第に小さくなり、やがてプレーニング状態となる。プレーニング時における摩擦抵抗は、フルトリムインの時に最も大きく、フルトリムアウト付近で最も小さくなる。通常、手動で停船時から最高速度まで加速を行う場合、フルトリムインの状態からスロットルを全開にし、ハンプを超えた時点から、次第に、トリムをピッチング及びダッチロールの発生しないトリム角まで、アウト側に操作する。こうすることで、造波抵抗と摩擦抵抗とを押さえることが可能になり、結果として、停船時あら最高速度に達するまでの時間が短縮される。しかしながら、トリムを操作するタイミング、操作する速度並びに最終的なトリム角は、艇体の種類が外乱によって大きく異なり、また、高度な操作技術を要求する。加速最適化制御部における自律型進化処理部は、例えば、遺伝的アルゴリズムを採用しており、図１２に示すようにトリム制御モジュールの制御パラメータ（トリムアウト開始速度Ｔ１、トリム作動速度Ｔ２、最終トリム角度Ｔ３）をコード化して個体を生成し、遺伝的アルゴリズムを用いて、これらの制御パラメータの最適化を行う。自律型進化処理中の各個体の評価は、目標となる加速特性、例えば、停船時から定められた速度に達するまでの時間が短いほど、評価値が高くなるように設定された評価部が行うように構成されており、その結果、トリム制御モジュールの制御パラメータは目標となる加速特性に向けて自動的に最適化され、使用環境や艇体が変化した場合においても、最適な加速特性が得られるようになる。また、加速最適化制御部における対話型進化処理部は、例えば、遺伝的アルゴリズムを採用しており、トリム制御モジュールの制御パラメータをコード化して個体を生成し、遺伝的アルゴリズムを用いて、これらの制御パラメータの最適化を行う。対話型最適化処理中の各個体の評価は、使用者が、実際に体感する乗り心地に基づいて行うように構成されており、その結果、トリム制御モジュールの制御パラメータは使用者の評価に従って最適化され、使用者の評価に合った最適な加速特性が得られるようになる。自律型進化処理部と対話型進化処理部の切り替えは予め定められた条件、例えば、時間に基づいて行っても良く、また、図７に示すようなインターフェイスを介して、使用者の意思に基づいて行ってもよい。具体的には、まず自

律型進化処理部で進化処理を行い、そこで得られた最適な加速特性を基に、対話型進化処理部で進化処理を行い、使用者の好みに合うように微調整を行うように構成しても良く、また、自律型進化処理中に、使用者の気に入らないような個体が発生した場合は、使用者がその場で評価値０を与え、次個体に切り替えるように構成してもよい。次に、上記した加速最適化制御部における進化処理について説明していく。図１３は、加速最適化制御部の進化処理の流れを示すフローチャートである。

ａ．自律型進化処理部における進化処理

図１３に示すように、始めに制御パラメータの初期値を予め決められた範囲でランダムに決定し、複数の初期個体からある第１世代を生成する（ステップ１－１）。そして、第１世代の全ての個体に対する加速最適化制御評価を行う（ステップ１－２）。ここで、加速最適化制御評価について簡単に説明すると、１個体につき１回、停船状態から定められた速度までスロットル全開で加速し、定められた速度に達するまでの時間を評価値として算出する。上記した評価値計算処理（ステップ１－２）で得られた各個体の評価血に基づいて、それが最適な加速特性か否かを評価し（ステップ１－３）、評価の結果、最適な加速特性が獲得できたか否かを判断する（ステップ１－４）。そして、最適な操船特性が得られていた場合には進化処理を終了し、得られていない場合には、進化型計算モジュールに入り、次世代の個体郡を生成する（ステップ１－５）。

ｂ．対話型進化処理部における進化処理

図１３に示すように、始めに制御パラメータの初期値を予め決められた範囲でランダムに決定し、複数の初期個体からなる第１世代を生成する（ステップ１－２）。そして、第１世代の何れかの個体のパラメータを用いて試乗を行い（ステップ２－２）、その個体に対する評価値を使用者が入力する（ステップ２－３）。前記評価値に基づいて、好みの加速特性が得られたか否かを判断し（ステップ２－４）、得られたと判断した場合には進化処理を終了し、得られていない場合には、１世代の全ての個体に対して試乗及び評価が終了したか否かを判断する（ステップ２－５）。全ての個体に対する試乗及び評価が終了していない場合には、トリム制御モジュールのパラメータを別の個体のものに変更し（ステップ２－６）、再び試乗を行わせる（ステップ２－２）。また、全ての個体に対する試乗及び評価が終了した場合には、進化型計算モジュールに入り（ステップ２－７）、次世代の個体郡を生成し、再び、それあの個体のパラメータを用いた試乗及び評価を行う。これらの処理は好みの加速特性が得られるまで繰り返し行われ、その結果、トリム制御モジュールのパラメータは最適化される。ここで、対話型を採用した加速特性の評価について説明すると、１個体につき１回、停船状態から定められた速度までスロットル全開で加速し、使用者が体感した加速感及び乗り心地に基づいて評価値を入力する。

【００１０】ここで、進化型計算モジュールの幾つかの例について説明する。

ａ．遺伝的アルゴリズム（ＧＡ）

図１４は、進化型計算法として遺伝的アルゴリズムを用いた場合の進化型計算モジュールの概略フローチャートである。このモジュールでは、１世代の個体全ての評価の終了後、好みの特性が得られたかった場合に、次世代の個体郡を生成する。スケーリング（ステップ１）については、個体郡内の最大適応度と平均適応度との比率が一定となるように適応度の線形変換を行う。選択（ステップ２）については、使用者の評価値（適応度）に比例して確率的に選択するルーレット選択方式が採用され得る。また、ランダムに選んだｎ個の個体の中で最良の評価値を持つものを選択するトーナメント選択方式を用いることもできる。交叉（ステップ３）には、１点交叉、２点交叉、又は正規分布交叉等の手法がある。尚、交叉のために選択された親が同一の個体であることもおこり得るが、これを放置すると個体郡としての多様性が失われることになるので、交叉に選択された親が同一の個体の場合には、他の選択された個体と入れ換えて、可能な限り、同じ個体の交叉を避ける。突然変異（ステップ４）については、個体の各遺伝子座について一定の確率で、ランダムに値を変更する。そのほかにも正規分布に従う摂動を加える方法も考えられる。異なる個体を交叉の親として選択したにもかかわらず、それらが遺伝的にみて全く同一である場合には、交叉する親の両方について、通常より高い確率で突然変異を生じさせる。また、上記の他に、一度に一世代の全ての個体を置き換える「再生」と呼ばれる世代交代の手法を用いてもよい。さらに、厳密に世代交代を適用した場合、評価の高い個体を破壊してしまう恐れがあるため、エリート（高い評価を獲得した任意の数の個体）を無条件に次世代に残すエリート保存戦略を合わせて用いてもよい。

ｂ．進化戦略（ＥＳ）

図１５は、進化型計算法として進化戦略を用いた場合の進化型計算モジュールの概略フローチャートである。このモジュールでは、１世代の個体全ての評価の終了後、好みの特性が得られなかった場合に、次世代の個体郡を生成する。選択（ステップ１）については、進化戦略の種類により選択の仕方が異なるので、ここでは、代表的な２種類の手法について説明する。（μ，λ）－ＥＳと呼ばれる進化戦略の場合、μ個の親個体から生成されたλ個の子個体の中から、適応度の良いものから順にμ個を確定的に選択する。（$\mu+\lambda$）－ＥＳと呼ばれる進化戦略の場合、μ個の親個体とλ個の子個体とを合わせた個体郡の中から、適応度の良いものから順にμ個を確定的に選択する。進化戦略には、上記の他に下記のような手法があり、これらを用いる場合には、これらの手法に合わせた選択の仕方を行う。

・（1，1）－ＥＳ：ランダムウォーク（ＲＷ）
・（1＋1）－ＥＳ：ヒルクライミング（ＨＣ）
・（1，λ）－ＥＳ，（1＋λ）－ＥＳ：近傍探索法
・（μ＋1）－ＥＳ：連続世代型多点探索法

交叉（ステップ2）については、正規分布交叉を用いるが、パラメータごとに親の値を継承したり、中点、内分点又は外分点を子の値としてもよい。突然変異（ステップ3）については、各パラメータに対して正規分布に従う摂動を加える。このとき、正規分布の分散はパラメータごとに調整を行っても良いし、パラメータ間の相関を持たせてもよい。以上説明したように進化戦略（ＥＳ）は、各パラメータを実数値のまま使用するため、遺伝的アルゴリズムのような表現型から遺伝子型への変換が不要になるという利点がある。また、正規分布交叉などの実数の連続性を考慮した交叉方法を用いることで、遺伝的アルゴリズムにおいてよく用いられるバイナリコードやグレイコードを１点交叉や多点交叉させるものよりも、親の形質を強く子の形質に反映させることができる。

ｃ．進化的プログラミング（ＥＰ）

図１６は、進化型計算手法として進化的プログラミングを用いた場合の進化型計算モジュールの概略フローチャートである。スケーリング（ステップ1）については、個体数がμ個の場合、摂動を加える前の個体と摂動を加えた後の個体を合わせた２μ個の個体について、それぞれランダムに選んだｑ個の個体と比較し、勝っている数をその個体の適合度とする。選択（ステップ2）は、生成された個体郡の中から適応度のよいものから順にμ個を選択する。選択は確定的であるが、スケーリングが確率的であるので、実質的には選択は確率的となる。以上説明した進化的プログラミング（ＥＰ）は、各パラメータを実数値のまま使用するため、遺伝的アルゴリズムのような表現型から遺伝子型への変化が不要になるという利点がある。また、交叉を用いないので、表現型に制約がない。遺伝的アルゴリズムは進化戦略のようにパラメータをストリング状にする必要があなく、木構造等でもよい。

【００１１】本実施例で説明した滑走艇は、天候や季節の変化により使用環境が著しく変動し、また、使用者の好みも著しく変動するものなので、全ての使用者があらゆる使用環境下において満足できる船速制御特性を設計の段階や出荷前のセッティングの段階で獲得することは実質的に不可能な制御対象であり、また、通常、船外機と船体とが別個に製造されるため、最適な船速制御を行うためには、使用環境及び使用者の特性に加えて、船体に合わせたスロットル制御及びトリム角制御が必要となり、制御装置にファジィ制御器を用いている場合、全ての条件に合わせてファジィ制御器の特性の最適化を行うのは非常に困難だが、以上説明したように、電子スロットル弁操作及びトリム操作を制御する制御装置１０の操船ファジィ制御モジュールのパラメータを、進化型計算を用いて実時間で最適化できるように構成することによって、これらの全ての条件に合った船速制御を行うことが可能になるという顕著な効果を奏する。

【００１２】以上説明した実施例では、エンジン回転数、速度、加速度、ステアリング角度等の情報を入力し、これらの入力情報に基づいて電子スロットル弁及びトリム装置を操作することにより、吸入空気量及び艇体の姿勢を制御することで定速航走制御を行い、定速航走制御部は、所定の入力情報に基づいて電子スロットル弁の開度とトリム角度を操船ファジィ制御モジュールによって決定し、前記操船ファジィ制御モジュールの規格化係数を自律型評価を用いて最適化を行い、前記操船ファジィ制御モジュールのファジィルールを対話型評価を用いて最適化し、また、速度を入力し、入力情報に基づいてトリム装置を操作することにより、姿勢を制御することで加速制御を行い、加速最適化制御部は、所定の入力情報に基づいてトリム角度をトリム制御モジュールによって決定し、前記トリム制御モジュールの制御パラメータを自律型評価及び対話型評価を用いて最適化した航走制御装置について説明しているが、本発明に航走制御装置は、上記した実施例に限定されることなく、例えば、評価を燃費消費率及び／又は消費電力に基づいて行ってもよく、使用者の乗り心地に基づいて行ってもよく、また、加速最適化制御部が電子スロットル制御モジュールを備えるように構成してもよい。また、上記した実施例では、滑走艇の船外機及びトリム装置について最適化を行うように構成されているが、これは本実施例に限定されることなく、例えば、図１７に示すように、エンジン及びウォータノズルトリム装置と、艇体とを組み合わせて組合せ完成品として使用されるパーソナルウォータクラフトにおけるエンジン及びウォータノズルトリム装置を単位装置として、本発明を適用した場合には、エンジンにおける電子スロットル弁装置及びウォータノズルトリム装置を制御する制御装置をパーソナルウォータクラフトとしての特性を評価基準として最適化して、吸入空気量及び艇体の姿勢の制御の最適化を行うことが可能になり、また、図１８に示すように、艇体と、ガソリンエンジンを搭載した船外機及びトリム装置とを組み合わせて組合せ完成品として使用される滑走艇における船外機及びトリム装置を単位装置として、本発明を適用した場合には、エンジンにおける電子スロットル弁装置とトリム装置とを制御する制御装置を滑走艇の特性を評価基準として最適化して吸入空気量及び艇体の姿勢の制御の最適化を行うことが可能になり、さらに、図１９に示すように、艇体と、ディーゼルエンジンを搭載した船外機及びフラップ可動装置とを組み合わせて組合せ完成品として用いられる滑走艇における船外機及びフラップ可動装置を単位装置として本発明を提供する場合には、エンジンにおける燃料噴射装置とフラップ可動装置とを制御す

る制御装置を滑走艇の特性を評価基準として最適化して燃料噴射量及び艇体の姿勢の制御の最適化を行うことが可能になる。

【００１３】

【発明の効果】以上説明したように、本発明は、航走特性に影響を及ぼす装置を備えた船舶において、所定の入力情報に基づいて前記航走特性に影響を及ぼす装置の操作量に関する出力を決定する制御モジュールを備えた航走特性制御装置を設け、前記航走特性制御装置に、船舶としての特性を評価対象として、実時間で、前記制御モジュールを最適化する最適化処理部を設けているので、多種多様で変化し易い使用者の好みや使用環境に、その都度適合した最適な航走特性を得ることが可能になるという効果を奏する。船外機は、艇体とは別個の製造され、取り付けられる艇体の種類も多種多様なので、使用者の好みや使用環境だけでなく、艇体との適合性も要求されるので、全てに適合した特性を得るのは非常に困難だが、請求項２に係る発明によれば、前記航走特性に影響を及ぼす装置が船外機であるので、上記したような問題点を解消できるという効果を奏する。また、請求項１０に係る発明によれば、前記最適化処理部が、予め設定された評価基準に基づいて最適化処理に関する評価を行うので、使用者に最適化処理に関する負担をかけることがないという効果を奏する。さらにまた、請求項１１に係る発明によれば、前記最適化処理部が、最適化処理に関する使用者意思に基づく評価を入力する手段とを備え、前記使用者意思に基づく評価に沿って最適化を行うので、最適化処理に使用者の好みを反映させることができるので、より使用者の好みに合った特性を得ることができ、また、使用者に、自分が最適化に参加しているという楽しみを与えることができるという効果を奏する。

【図面の簡単な説明】

【図１】　本発明に係る航走特性制御装置の一実施例を示す概略ブロック図である。

【図２】　船外機及びトリム装置と制御装置との関係を示す概略図である。

【図３】　制御装置１０の内部構成を示す概略ブロック図である。

【図４】　制御装置１０の内部構成を示す概略ブロック図である。

【図５】　操船ファジィ制御モジュールの規格化係数と、それをコード化して生成された個体との関係を概念的に示す図である。

【図６】　操船ファジィ制御モジュールのファジィルールテーブルと、その一部をコード化して生成された個体との関係を概念的に示す図である。

【図７】　定速航走制御部の進化処理の流れを示すフローチャートである。

【図８】　複数の個体を時分割で評価する時の時分割の仕方の一例を示すグラフである。

【図９】　通常制御モードと進化モードの切り換えを行うインターフェースの一例を示す図である。

【図１０】　ファジィルールの適合度の累計を求め方の一例を示す図である。

【図１１】　船舶の速度—抵抗曲線とトリム位置との関係を示すグラフである。

【図１２】　加速最適化制御部における自律型進化処理部で用いられる個体の一例を示す図である。

【図１３】　加速最適化制御部の進化処理の流れを示すフローチャートである。

【図１４】　進化型計算法として遺伝的アルゴリズムを用いた場合の進化型計算モジュールの概略フローチャートである。

【図１５】　進化型計算法として進化戦略を用いた場合の進化型計算モジュールの概略フローチャートである。

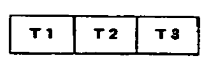
【図１６】　進化型計算手法として進化的プログラミングを用いた場合の進化型計算モジュールの概略フローチャートである。

【図１７】　本発明の別の適用例を示す概略図である

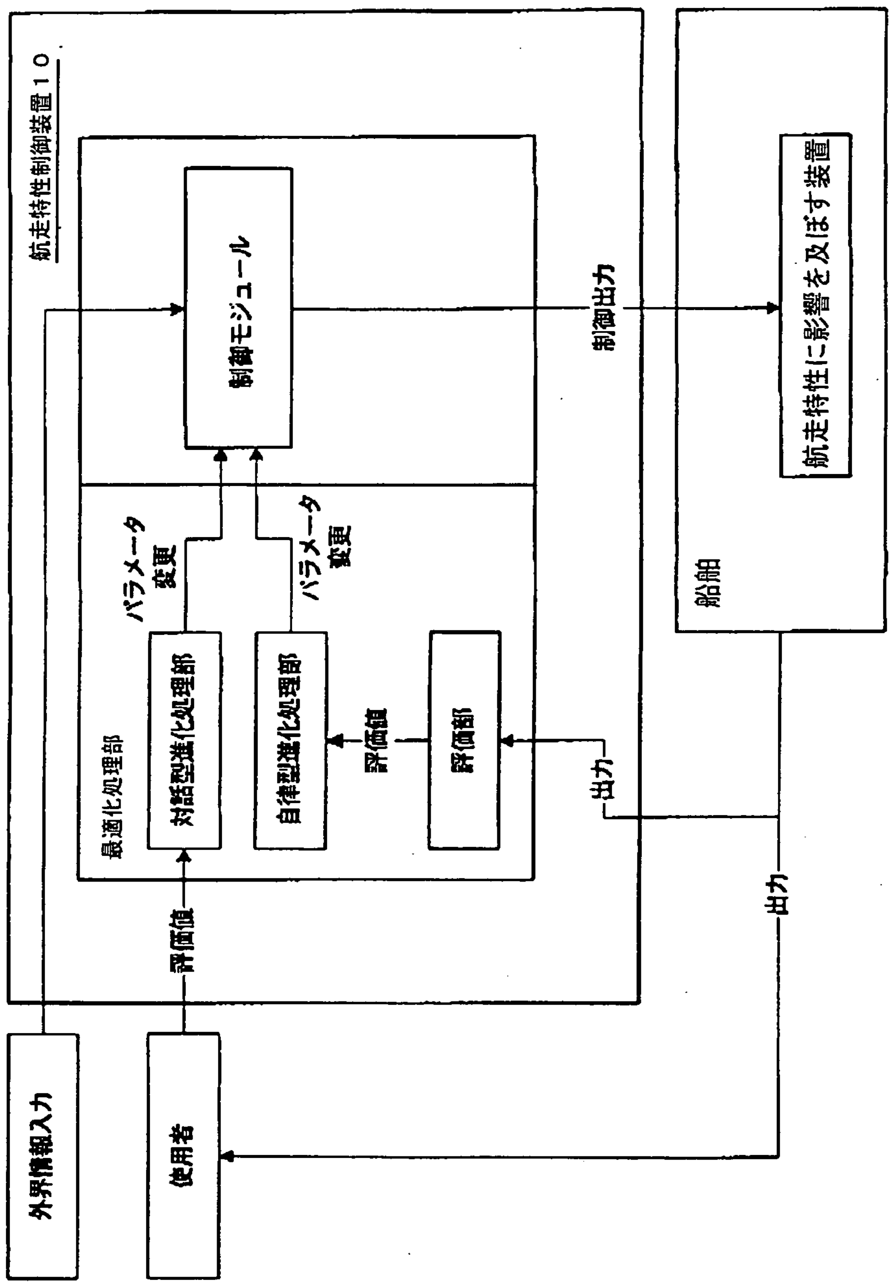
【図１８】　本発明のさらに別の適用例を示す概略図である。

【図１９】　本発明のさらに別の適用例を示す概略図である。

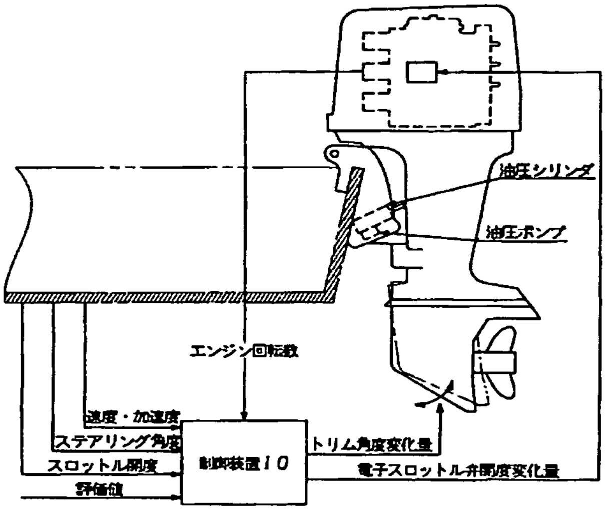
【図１２】



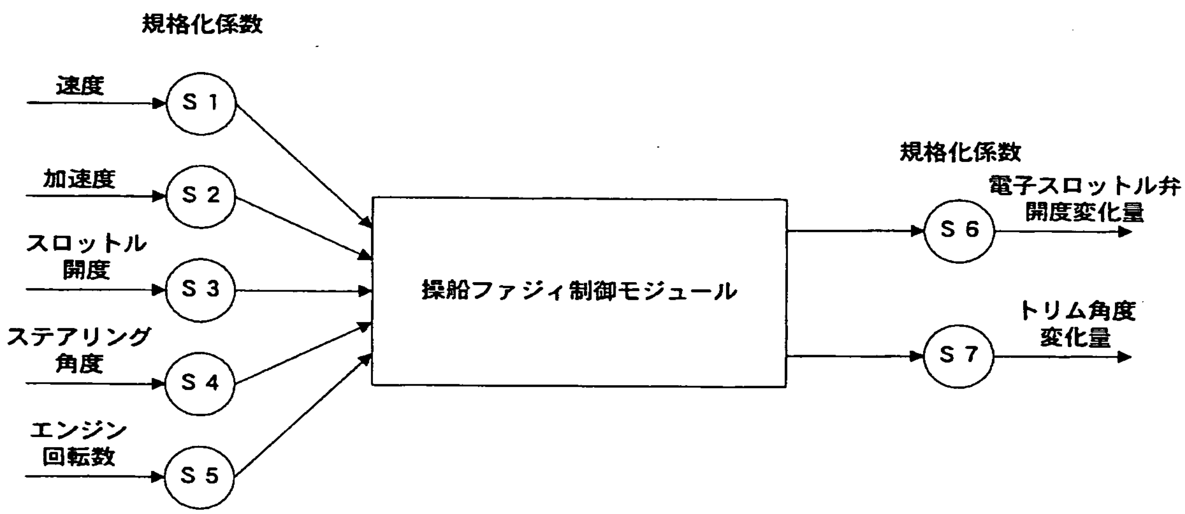
【図１】


航走特性制御装置１０
制御モジュール
制御出力
航走特性に影響を及ぼす装置
船舶
パラメータ変更
パラメータ変更
最適化処理部
対話型進化処理部
自律型進化処理部
評価部
評価値
出力
出力
評価値
外界情報入力
使用者

【図２】

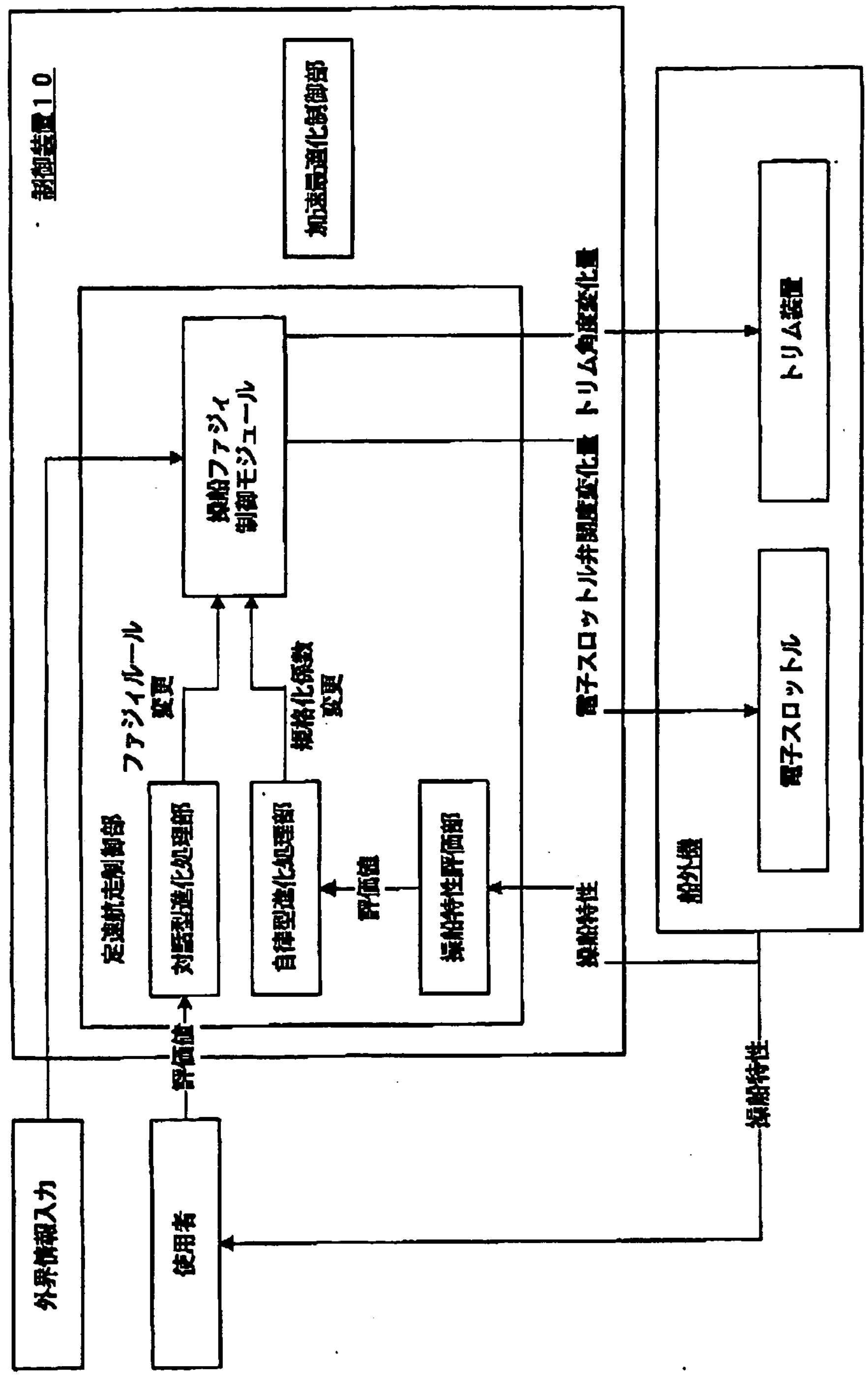


【図５】

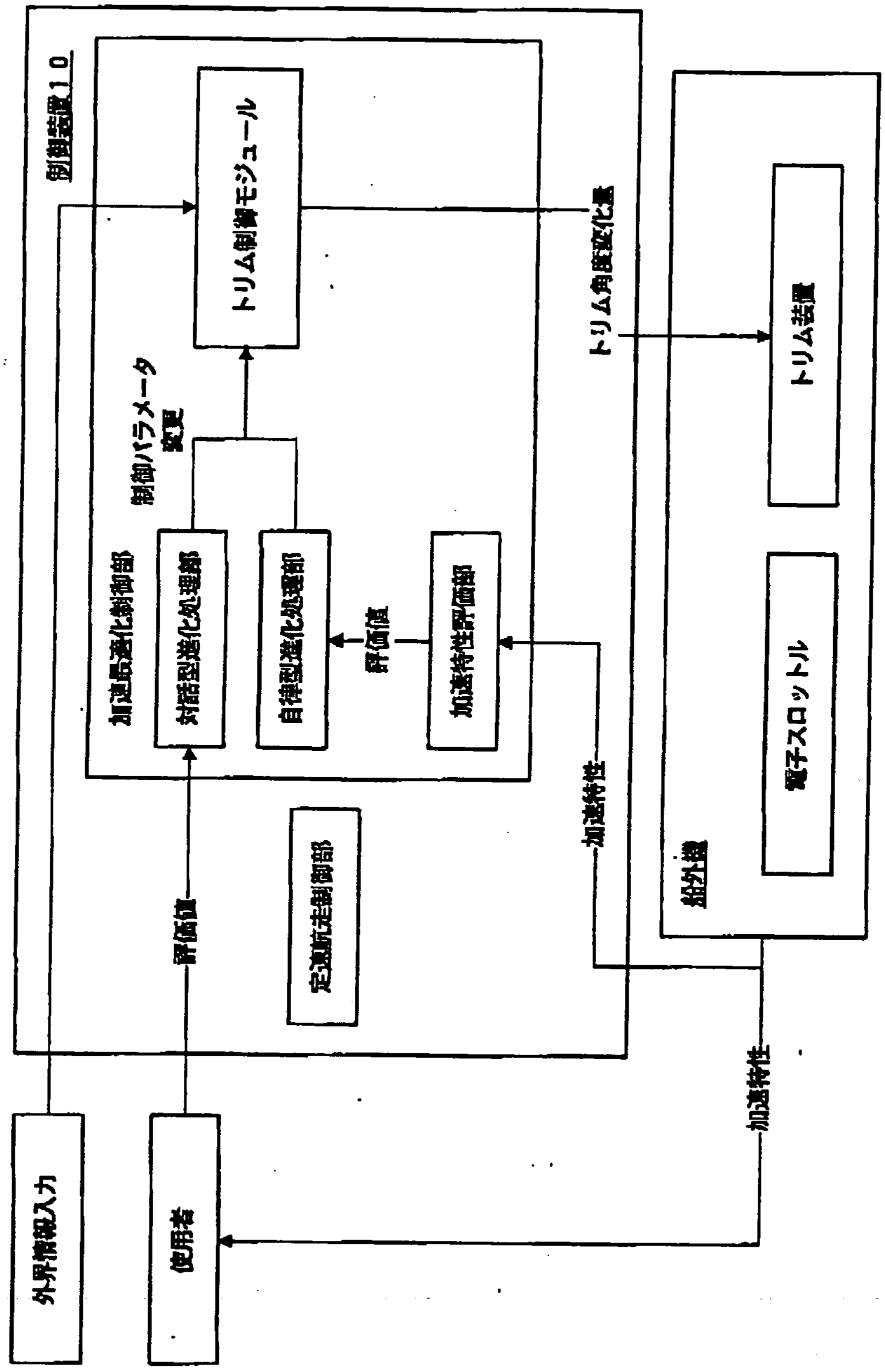


Ｓ１	Ｓ２	Ｓ３	Ｓ４	Ｓ５	Ｓ６	Ｓ７

【図３】


制御装置１０
加速器進化制御部
定速航走制御部
操船ファジィ制御モジュール
ファジィルール変更
規格化係数変更
対話型進化処理部
自律型進化処理部
操船特性評価部
評価値
評価値
トリム角度変化量
電子スロットル弁開度変化量
操船特性
船外機
トリム装置
電子スロットル
操船特性
外界情報入力
使用者

【図４】


制御装置１０
トリム制御モジュール
制御パラメータ変更
加速最適化制御部
対話型進化処理部
自律型進化処理部
評価値
加速特性評価部
加速特性
定速航走制御部
評価値
トリム角度変化量
トリム装置
電子スロットル
船外機
加速特性
外界情報入力
使用者

【図６】

速度

加速度	ＦＡＳＴ	ＭＩＤ	ＳＬＯＷ
ＰＬ	－１０°	－５°	－１°
ＰＳ	－５°	－１°	０°
ＺＲ	－１°	① ０°	③ ＋１°
ＮＳ	０°	② ＋１°	④ ＋５°
ＮＬ	＋１°	＋５°	＋１０°

ファジィルールテーブル

入力：速度，加速度
出力：電子スロットル弁開度変化量

$\xrightarrow{\text{抽出}}$

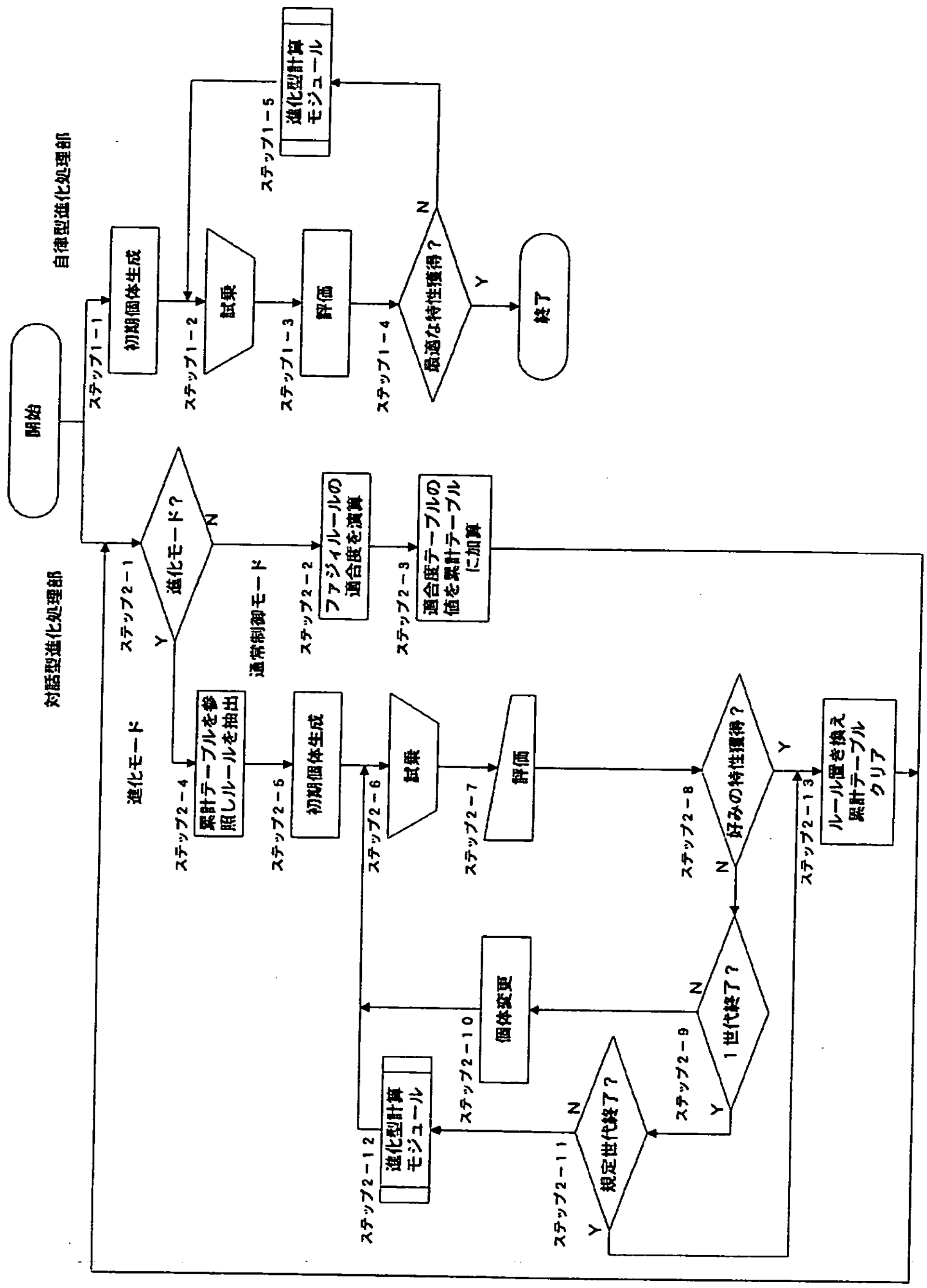
①	②	③	④
０°	＋１°	＋１°	＋５°

↓ 正規乱数を加えた摂動

＋０．５°	＋１．３°	＋０．４°	＋６．１°
－０．３°	＋１．４°	＋２．０°	＋４．９°
＋０．９°	＋０．６°	＋１．５°	＋５．２°

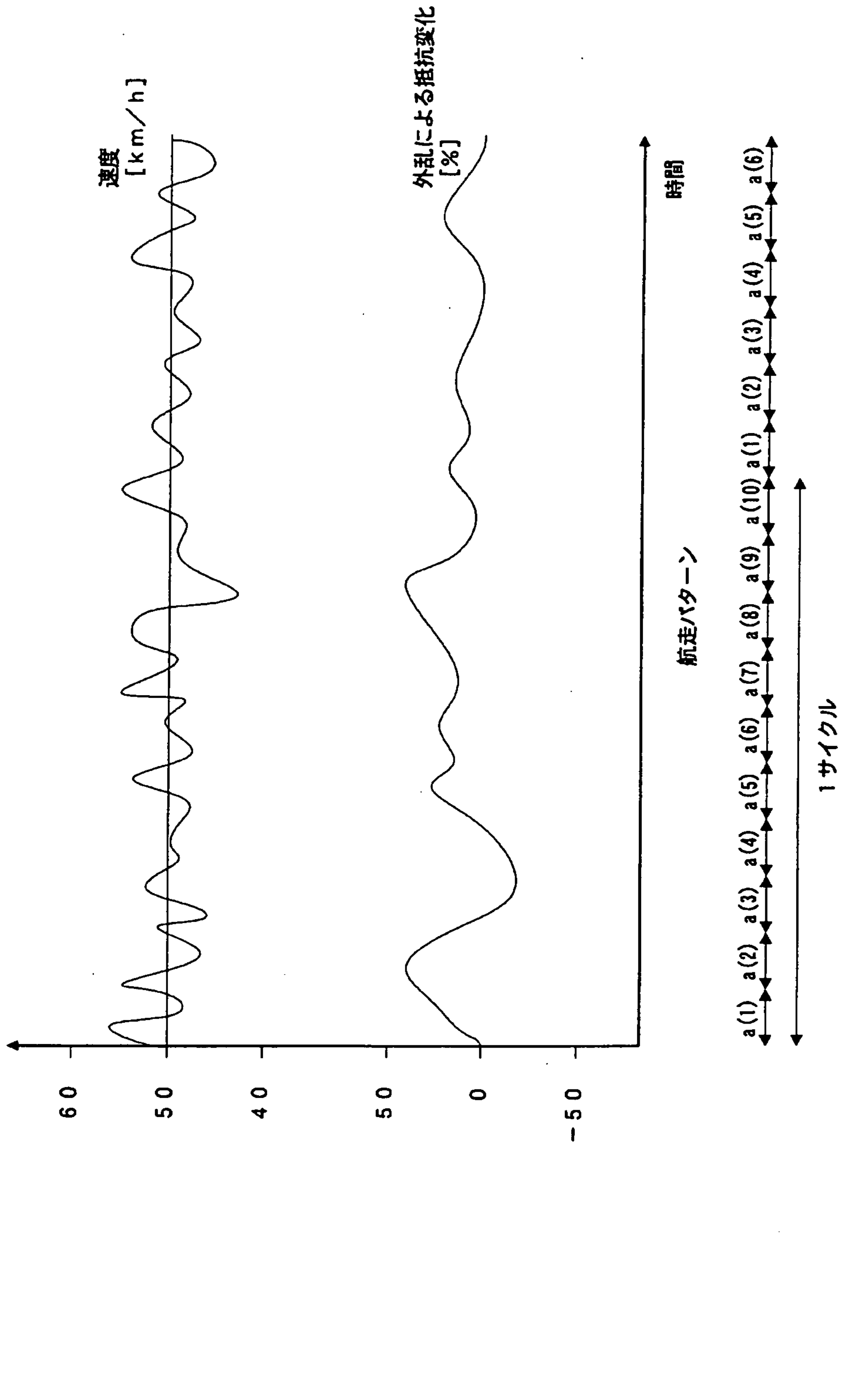
●
●
●

【図７】

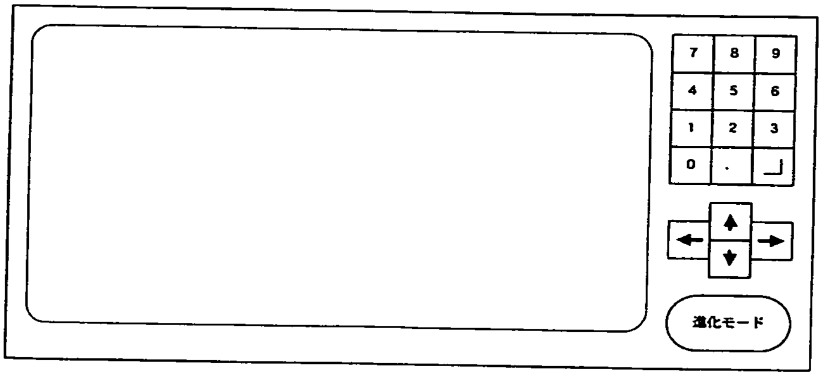


開始
自律型進化処理部
ステップ１－１
初期個体生成
ステップ１－２
試乗
ステップ１－３
評価
ステップ１－４
最適な特性獲得？
Y
N
終了
ステップ１－５
進化型計算モジュール
対話型進化処理部
ステップ２－１
進化モード？
Y
N
通常制御モード
ステップ２－２
ファジィルールの適合度を演算
ステップ２－３
適合度テーブルの値を累計テーブルに加算
進化モード
ステップ２－４
累計テーブルを参照しルールを抽出
ステップ２－５
初期個体生成
ステップ２－６
試乗
ステップ２－７
評価
ステップ２－８
好みの特性獲得？
Y
N
ステップ２－１３
ルール置を換え累計テーブルクリア
ステップ２－９
１世代終了？
N
Y
ステップ２－１０
個体変更
ステップ２－１１
規定世代終了？
N
Y
ステップ２－１２
進化型計算モジュール

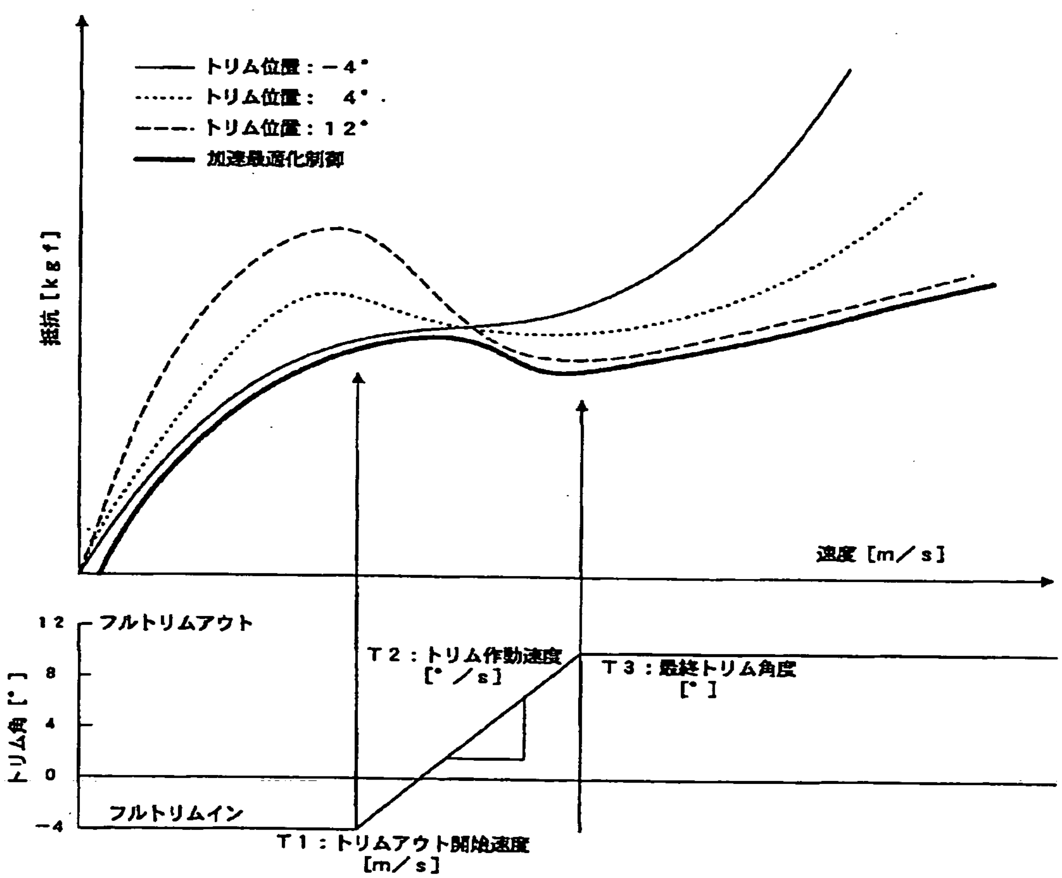
【図８】


速度
[km/h]
外乱による抵抗変化
[%]
時間
航走パターン
1サイクル
a(1) a(2) a(3) a(4) a(5) a(6) a(7) a(8) a(9) a(10) a(1) a(2) a(3) a(4) a(5) a(6)
60
50
40
50
0
－50

【図９】


7
8
9
4
5
6
1
2
3
0
.
進化モード

【図１１】


トリム位置：－４°
トリム位置：　４°
トリム位置：１２°
加速最適化制御
抵抗［ｋｇｆ］
速度［ｍ／ｓ］
１２
８
４
０
－４
フルトリムアウト
フルトリムイン
トリム角［°］
Ｔ２：トリム作動速度
［°／ｓ］
Ｔ３：最終トリム角度
［°］
Ｔ１：トリムアウト開始速度
［ｍ／ｓ］

【図１０】

適合度テーブル

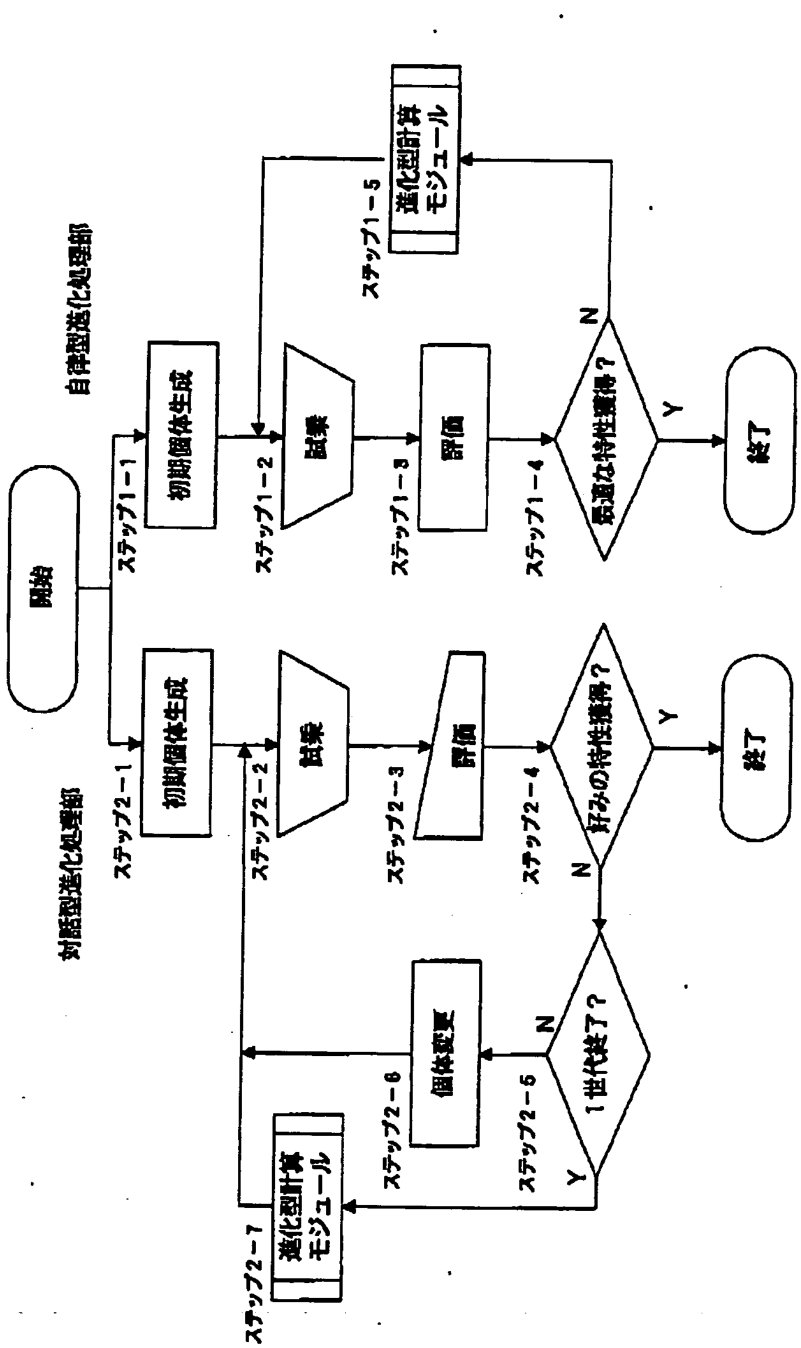
加速度＼速度	FAST	MID	SLOW
PL			
PS		0.42	0.28
ZR		0.18	0.12
NS			
NL			

加算 →

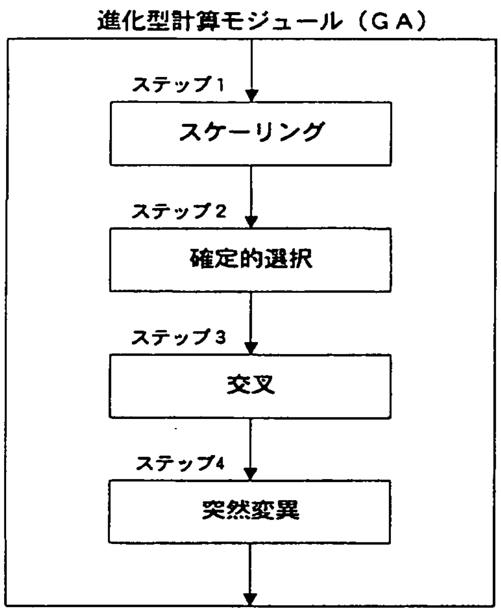
累計テーブル

加速度＼速度	FAST	MID	SLOW
PL	0.02	1.87	0.27
PS	4.96	8.39	3.72
ZR	12.61	① 86.42	③ 35.48
NS	9.55	② 49.75	④ 22.37
NL	8.96	18.19	2.44

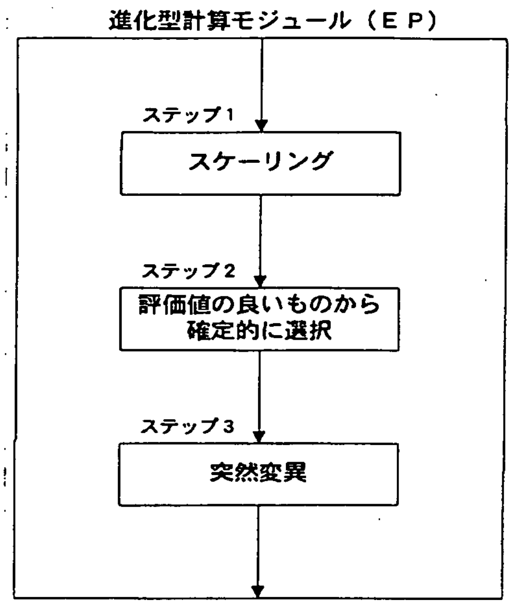
【図１３】


自律型進化処理部
対話型進化処理部
開始
ステップ1－1
初期個体生成
ステップ1－2
試乗
ステップ1－3
評価
ステップ1－4
最適な特性獲得？
Y
N
終了
ステップ1－5
進化型計算モジュール
ステップ2－1
初期個体生成
ステップ2－2
試乗
ステップ2－3
評価
ステップ2－4
好みの特性獲得？
Y
N
終了
ステップ2－5
1世代終了？
N
Y
ステップ2－6
個体変更
ステップ2－7
進化型計算モジュール

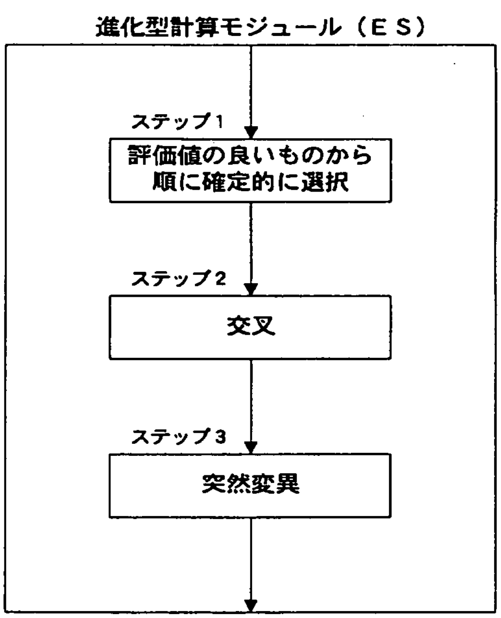
【図１４】


進化型計算モジュール（ＧＡ）
ステップ1
スケーリング
ステップ2
確定的選択
ステップ3
交叉
ステップ4
突然変異

【図１６】


進化型計算モジュール（ＥＰ）
ステップ1
スケーリング
ステップ2
評価値の良いものから
確定的に選択
ステップ3
突然変異

【図１５】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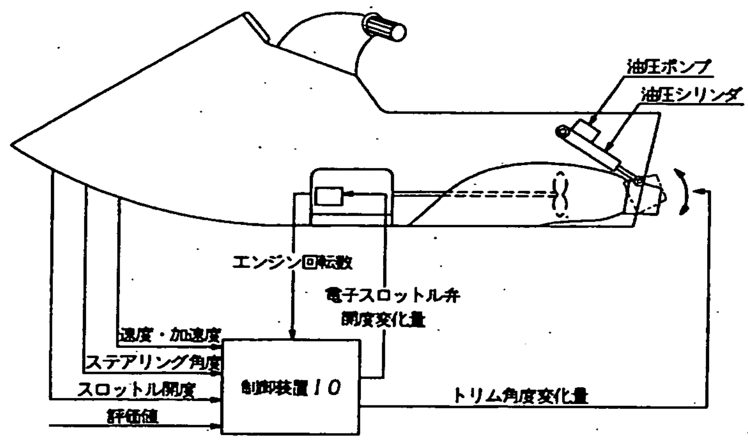
ステップ1
評価値の良いものから
順に確定的に選択
ステップ2
交叉
ステップ3
突然変異

【図１７】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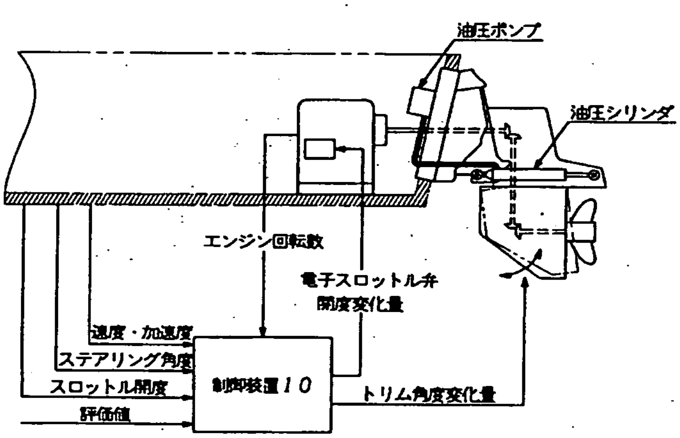
ステアリング角度
スロットル開度
評価値
制御装置１０
トリム角度変化量

【図１８】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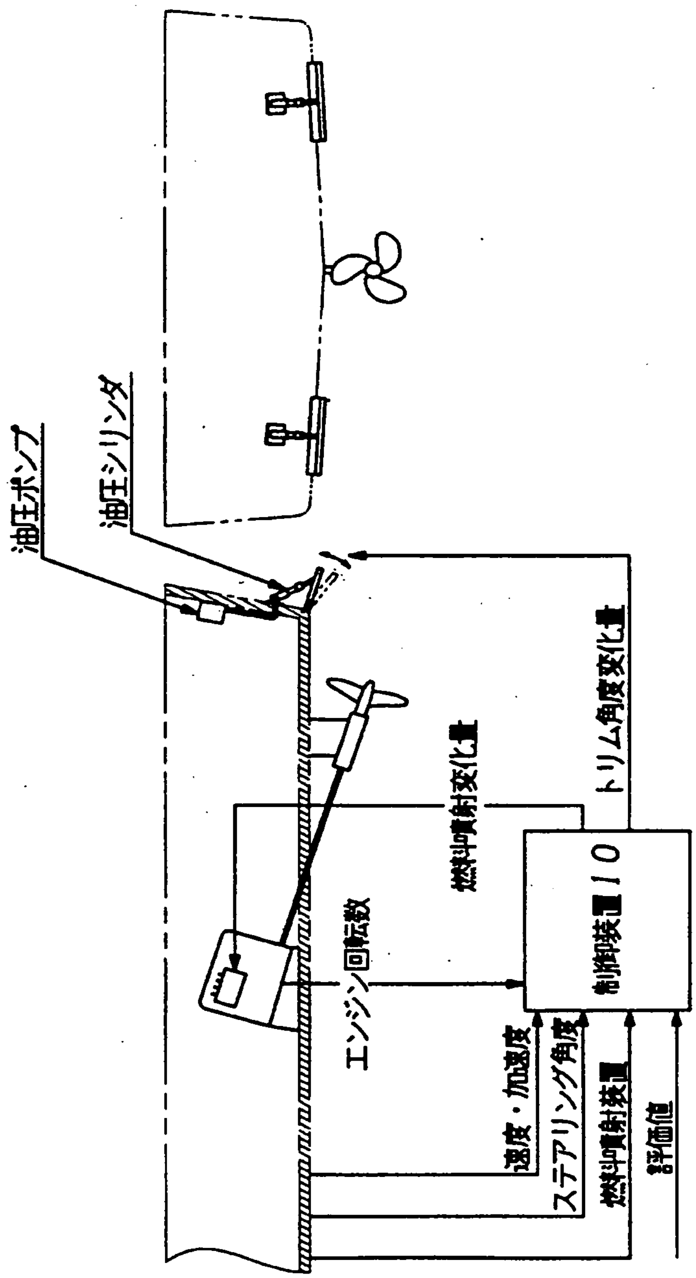
トリム角度変化量

【図１９】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速度・加速度
ステアリング角度
燃料噴射装置
評価値

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		３７０			Ｎ

(72)発明者　松下　行男
静岡県浜松市新橋町1400番地　三信工業株式会社内

(72)発明者　梶　洋隆
静岡県磐田市新貝2500番地　ヤマハ発動機株式会社内

(72)発明者　山口　昌志
静岡県磐田市新貝2500番地　ヤマハ発動機株式会社内

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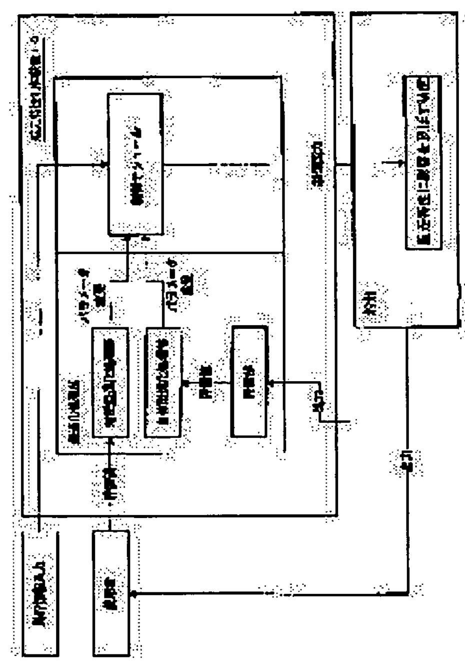
(71)Applicant : SANSHIN IND CO LTD
YAMAHA MOTOR CO LTD
(72)Inventor : HARADA HIROSHI
MATSUSHITA YUKIO
KAJI HIROTAKA
YAMAGUCHI MASASHI

(54) CRUISING CHARACTERISTIC CONTROL DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a cruising characteristic control device and to solve problems according to the conventional technique and allowing an optimum cruising to suit the user's taste, service environment, etc.
SOLUTION: This cruising characteristic control device for a ship equipped with arrangement influencing the cruising characteristics is furnished with a control module which decides the output concerning the manipulated variables of the arrangement, influencing the characteristics on the basis of the input information prescribed and also with an optimizing processing part to optimize the control module on the real-time basis, whereby the characteristics required of a ship are evaluated.



LEGAL STATUS

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CLAIMS

[Claim(s)]
[Claim 1] The sailing property control unit which forms the sailing property control unit equipped with the control module which opts for the output about the control input of the equipment which affects said sailing property based on predetermined input in the marine vessel equipped with the equipment which affects a sailing property, and is characterized by making the property as a marine vessel applicable to assessment at said sailing property control unit by to prepare the optimization-processing section which optimizes said control module in the real time.
[Claim 2] A sailing property control unit according to claim 1 characterized by said sailing property control unit being a control unit which controls the operating characteristic of said prime mover including an outboard motor with which equipment which affects said sailing property was equipped with a prime mover.
[Claim 3] A sailing property control unit according to claim 2 characterized by equipping said prime mover with electronic throttle equipment and/or electronically-controlled-gasoline-injection equipment, and said control unit controlling an electronic throttle-valve opening and/or fuel oil consumption.
[Claim 4] A sailing property control unit given in any 1 term of claims 1-3 characterized by said sailing property control unit being a control unit which controls whenever [angle-of-trim / of said trimming gear] including an outboard motor with which equipment which affects said sailing property was equipped with a trimming gear.
[Claim 5] A sailing property control unit according to claim 1 characterized by equipment which affects said sailing property being a control unit with which said sailing property control unit controls the operating characteristic of said prime mover including a prime mover formed in **.
[Claim 6] A sailing property control unit according to claim 5 characterized by equipping said prime mover with electronic throttle equipment and/or electronically-controlled-gasoline-injection equipment, and said control unit controlling an electronic throttle-valve opening and/or fuel oil consumption.
[Claim 7] A sailing property control unit given in any 1 term of claims 1-6 characterized by said sailing property control unit being a control unit which controls the operating characteristic of working flap equipment at least including working flap equipment with which equipment which affects said sailing property is attached in a flying-boat hull.
[Claim 8] A sailing property control unit given in any 1 term of claims 5-8 characterized by for said prime mover being a prime mover for generating a stream for generating driving force, and equipment which affects said sailing property being a control unit with which said sailing property control unit controls the operating characteristic of said water nozzle trimming gear at least including a water nozzle trimming gear which can change sense of said stream.
[Claim 9] A sailing property control unit given in any 1 term of claims 1-7 characterized by being constituted so that a control input of equipment with which a control module in said sailing property control unit affects said sailing property may be outputted and the optimization processing section may optimize a control parameter of said control module.
[Claim 10] A sailing property control unit given in any 1 term of claims 1-7 which is equipped with the following and characterized by constituting said optimization processing section so that

a control parameter of said control module for amendment may be optimized. A basic control module with which a control module in said sailing property control unit outputs a control input of equipment which affects said sailing property based on predetermined input Based on predetermined input, it has output **** for the amount of amendments or a correction factor to said control input, and is a control module for amendment.

[Claim 11] A sailing property control unit given in any 1 term of claims 1-10 characterized by having optimization operation part to which said optimization processing section performs an operation about an optimization technique, and the autonomous mold assessment section which performs assessment about optimization processing based on an error criterion set up beforehand.

[Claim 12] A sailing property control unit given in any 1 term of claims 1-10 characterized by equipping said optimization processing section with optimization operation part which performs an operation about an optimization technique, and a means to input assessment based on a user intention about optimization processing, and optimizing along with assessment based on said user intention.

[Claim 13] A sailing property control unit given in any 1 term of claims 9-12 to which said predetermined input is characterized by including at least any of ****, ******, ****, a steering angle, a throttle control input, or an engine speed they are.

[Claim 14] A sailing property control unit given in any 1 term of claims 1-13 to which a property as a marine vessel used as said object for assessment is characterized by including specific fuel consumption and/or power consumption at least.

[Claim 15] A sailing property control unit given in any 1 term of claims 1-14 characterized by including the flattery nature of fixed-speed sailing control to **** which time amount until a property as a marine vessel used as said object for assessment reaches full speed from the time of a stop at least, and/or a user specified.

[Claim 16] A sailing property control unit given in any 1 term of claims 1-15 to which a property as a marine vessel used as said object for assessment is characterized by being the degree of comfort of a marine vessel at least.

[Claim 17] A sailing property control unit given in any 1 term of claims 1-16 characterized by being constituted so that said optimization assessment section may perform an operation about optimization using heuristics.

[Claim 18] A sailing property control unit according to claim 17 characterized by said heuristics being an evolution mold numerical orientation method.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the sailing property control unit which enables optimal sailing according to a user's liking, an operating environment, etc.
[0002]
[Description of the Prior Art] It ****, where the outboard motor used from the former, being attached in the back of a flying-boat hull is attached in a flying-boat hull before shipment, and setting of the property of the engine and trimming gear is performed.
[0003]
[Problem(s) to be Solved by the Invention] However, since an operating environment is remarkably changed by change of the weather or a season and liking of a user is also changed remarkably, a marine vessel is usually difficult to set the engine and trimming gear of an outboard motor so that the sailing property all users can be satisfied with the bottom of all operating environments of a property may be acquired. For this reason, it does not restrict that the property set in the phase of **** since the time of setting differs from a loading condition when using a marine vessel actually, and disturbance, such as a wave, was also received and the time of setting differed from an operating environment remarkably in many cases is not necessarily the optimal, but it may be sensed to a user depending on the case that it is uncomfortable to ride in. Such a trouble is common not only for the marine vessel of the type carrying an outboard motor but the marine vessel which carried the prime mover in ** and the marine vessel furnished with working flap equipment. This invention solves the above-mentioned conventional trouble, and aims at offering the sailing property control unit which enables optimal sailing according to a user's liking, an operating environment, etc.
[0004]
[Means for Solving the Problem] In order to attain the above-mentioned object, a sailing property control unit concerning this invention A sailing property control unit equipped with a control module which opts for an output about a control input of equipment which affects said sailing property based on predetermined input in a marine vessel equipped with equipment which affects a sailing property is formed. It is characterized by preparing the optimization processing section which is the real time and optimizes said control module by making a property as a marine vessel applicable to assessment at said sailing property control unit.
[0005]
[Embodiment of the Invention] The gestalt of operation of the sailing property control unit concerning this invention is explained referring to some examples shown in the accompanying drawing hereafter. Drawing 1 is the outline block diagram showing one example of the sailing control unit concerning this invention. As shown in a drawing, this sailing control unit made suitable external world information input, based on that input, determined the information about the control input of the equipment which affects a sailing property, and is equipped with the control module to output. Preferably, although this control module may be the control module which has adopted the fuzzy inference system, for example, a fuzzy control machine, a fuzzy

decision-making system, or a fuzzy neuro-controller, it is not limited to this. Moreover, this sailing control unit is equipped with the optimization processing section, and it has the interactive evolution processing section and/or the autonomous mold evolution processing section, and by these evolution processing sections, by making the property as a marine vessel applicable to assessment, this optimization processing section is the real time, and optimizes the parameter of said control module. As long as the parameter which should be optimized is a parameter about a control module, the parameter of arbitration is sufficient as it, for example, when the fuzzy inference system is adopted, the normalization coefficient of the parameter for deciding the number, the configuration, the location, and breadth of a member cypripedium function, a fuzzy rule, or an I/O value etc. is mentioned. Moreover, it is carried out about the assessment for optimization by the assessment section by which the user was beforehand designed based on the predetermined error criterion to a direct deed and the autonomous mold assessment processing section to the interactive evolution processing section. Thus, it becomes possible to fit the property of a marine vessel to a user's liking and operating environment in the real time with constituting from the real time by making the property as a marine vessel applicable to assessment, so that the operating characteristic of the equipment which affects a sailing property can be optimized.
[0006] Next, the example which specified the controlled system for the example of application of the sailing property control unit concerning this invention is given and explained. Drawing 2 – drawing 17 show the example which applied the optimization method concerning this invention to the outboard motor and trimming gear of a planing boat. Drawing 2 is the schematic diagram showing the relation between an outboard motor and a trimming gear, and a control unit. When liking of the navigation in favorite temporal response, for example, spring, and autumn of the user same [not to mention] when the control unit is shown, and this control unit 10 acquires the optimal navigation property and the acceleration property of realizing change, the fixed-speed air-mail control according to disturbance, and the acceleration optimum control of a flying-boat hull and liking of a user, i.e., a user, differs changes, even if the inside of drawing and a sign 10 respond, they are constituted so that the optimal navigation property and an acceleration property may acquire. In addition, in this example, a ″navigation property″ means the thing of the vessel speed control characteristic by electronic throttle-valve actuation and the trim adjustment. By inputting information, such as an engine speed, speed, acceleration, a steering angle, and a throttle opening, and operating an electronic throttle valve and the trimming gear equipped with the oil hydraulic cylinder and the hydraulic pump based on these input, a control unit 10 controls the position of an inhalation air content and a hull, and performs fixed-speed sailing control and an acceleration optimum control.
[0007] Drawing 3 and drawing 4 are the outline block diagrams showing the internal configuration of a control unit 10. As shown in a drawing, this control unit 10 has a fixed-speed sailing control section and the acceleration optimum-control section. A fixed-speed sailing control section has the navigation fuzzy control module which determines the opening of an electronic throttle valve, and whenever [angle-of-trim] based on predetermined input, the autonomous mold evolution processing section which optimizes the normalization coefficient of said navigation fuzzy control module, the navigation nature assessment section which performs assessment of the autonomous mold evolution processing section, and the interactive evolution section which optimizes the fuzzy rule of said navigation fuzzy control module, as shown in drawing 3 . Moreover, the acceleration optimum-control section has the trim control module which determines whenever [angle-of-trim] based on predetermined input, the autonomous mold evolution processing section which optimizes the control parameter of said trim control module, the acceleration nature assessment section which performs assessment of the autonomous mold evolution processing section, and the interactive evolution processing section which optimizes the control parameter of said trim control module, as shown in drawing 4 . In addition, the above ″a normalization coefficient″ means the coefficient which adjusts the magnitude of I/O information.
[0008] 1. Control in a fixed-speed sailing control section : as a fuzzy inference system, for example, the simple reasoning method is used for a navigation fuzzy control module, and it

outputs variation whenever [electronic throttle-valve opening variation / to an engine speed, speed, acceleration, and a steering angle /, and angle-of-trim]. Said fuzzy rule table may be designed based on an expert's navigation information, and the fuzzy rule in the simple reasoning method is expressed with a real number value. The genetic algorithm is used for the autonomous mold evolution processing section in a fixed-speed sailing control section, as shown in drawing 5 , it codes the normalization coefficient of said navigation fuzzy control module, generates an individual, and it optimizes these normalization coefficients using a genetic algorithm. The navigation property that assessment of the each object under autonomous mold evolution processing serves as an aim For example, it is constituted so that the assessment section set up so that the deflection of the real speed to the speed which the user defined approached below desired value and an assessment value might become high may carry out. Consequently, the normalization coefficient of a navigation fuzzy control module is automatically optimized towards the navigation property used as an aim, and when an operating environment and a flying-boat hull change, the optimal navigation property comes to be acquired. Thus, the assessment section designed beforehand performs assessment in evolution processing, and autonomous mold assessment is called for the method of enabling it to optimize automatically on these descriptions. Moreover, the genetic algorithm is used for the interactive evolution processing section in a navigation control section, as shown in drawing 6 , it codes some fuzzy rule tables of said navigation fuzzy control module, generates an individual, and it optimizes some of these fuzzy rule tables using a genetic algorithm. It is constituted so that a user may perform assessment of the each object under interactive optimization processing based on the degree of comfort felt actually, consequently some fuzzy rule tables of a navigation fuzzy control module are optimized according to assessment of a user, and the optimal navigation property suitable for assessment of a user comes to be acquired. Thus, how a user performs assessment in evolution processing is called interactive assessment on these descriptions. Next, the evolution processing in the above-mentioned fixed-speed sailing control section is explained. Drawing 7 is a flow chart which shows the flow of evolution processing of a fixed-speed sailing control section. As mentioned above, in this control unit, in case evolution processing is performed, autonomous mold assessment is performed about the autonomous mold evolution processing section of a fixed-speed sailing control section, and interactive assessment is used about the interactive evolution processing section. Since the flows of optimization processing differ when the assessment methods differ, the following explanation divides and explains the evolution processing which adopted the autonomous mold assessment method, and the evolution processing which adopted the interactive assessment method.

a. As shown in evolution processing drawing 7 in the autonomous mold evolution processing section, determine at random within limits which determined the initial value of a normalization coefficient beforehand first, and generate the 1st generation which consists of two or more initial individuals (step 1-1). And fixed-speed sailing control evaluation to all the individuals of the 1st generation is performed (step 1-2). Here, if fixed-speed sailing control evaluation is explained briefly, two or more individuals are operated in parallel in false by time sharing, and the assessment value in the sum total of the period is compared. assessment is changed according to the activity region of an engine speed, for example, as shown at drawing 8 in the case of the troll using an engine low revolution region, about ten individuals, it controls every [1] and the absolute value of the difference of the real speed to aim speed is totaled for every sampling time, and specifically, the totalizer within 20 cycle repeat and an assessment period is computed as an assessment value by making this into 1 cycle. Since the effect by disturbance, such as the weather and a hydrographic condition (specifically for example, a wind and a wave), is arranged as total with an each object, carrying out like this can estimate the property of an each object impartially. In the case of the cruise using an engine high revolution region, to the above mentioned assessment method moreover, in order to control the unstable behavior generated at the time of a high speed, i.e., pitching to which a flying-boat hull shakes up and down, and the Dutch roll shaken at right and left, [in addition,] When pitching or the Dutch roll is detected, 0 is given as an assessment value of an individual, a flying-boat hull is stabilized by decreasing an angle of trim to the angle which pitching or the Dutch roll does not generate, and an each object

is henceforth evaluated by making the angle into the maximum angle of trim. By carrying out like this, it can prevent that unstable behavior occurs at the time of a high speed. Based on the assessment value of the each object acquired by the above-mentioned assessment value computation (step 1-2), it evaluates whether it is the optimal navigation property (step 1-3), and judges whether the optimal navigation property has been acquired as a result of assessment (step 1-4). And when the optimal navigation property is acquired, evolution processing is ended, when not obtained, it goes into an evolution mold count module, and a next-generation population is generated (step 1-5).

b. As shown in evolution processing drawing 7 in the interactive evolution processing section, there are usually the control mode and evolution mode in the interactive evolution processing section. Usually, a switch (step 2-1) in the control mode and evolution mode may be performed based on a user's volition through an interface as performed based on the conditions decided beforehand, for example, time amount, and shown in drawing 9 . Usually, in the control mode, fuzzy control is performed using the fuzzy rule table decided at the event, and the accumulating totals of the goodness of fit of each fuzzy rule until it changes to evolution mode simultaneously are searched for (step 2-2). It ends, when it adds to the accumulating-totals table which calculates the accumulating totals of a goodness of fit until it changes the result of an operation of a goodness of fit table which calculates the goodness of fit of each fuzzy rule in a certain time of day to evolution mode (step 2-3) and this is specifically changed to evolution mode, as shown in drawing 10 . If it changes to evolution mode, a number of arbitration of fuzzy rules which correspond to drawing 7 with reference to an accumulating-totals table so that it may be shown will be coded for a chromosome sequentially from the large thing of accumulating totals (step 2-4), the perturbation which followed the normal distribution by making this into initial value will be added, and the 1st generation which consists of two or more initial individuals will be generated (step 2-5). And it test-rides using the parameter of one individual of the 1st generation (step 2-6), and a user inputs the assessment value over the individual (step 2-7). When it judges whether the favorite navigation property was acquired (step 2-8) and it is judged based on said assessment value that it was obtained, evolution processing is ended by making the individual into the maximum superior individual, and when not obtained, a trial ride and assessment judge whether it is the termination method no to all the individuals of one generation (step 2-9). When all individuals and assessment are not completed, the fuzzy rule of a fuzzy control module is changed into the thing of another individual (step 2-10), and it is made to test-ride again (step 2-6). moreover, when the trial ride and assessment to all individuals are completed When it judges whether the convention generation number was reached (step 2-11) and it is judged that it reached In the generation, by making an individual with the highest assessment value into the maximum superior individual, when it ends and it is judged that evolution processing has not reached, it goes into an evolution mold count module (step 2-12), and a next-generation individual county is generated, and the trial ride and assessment using a fuzzy rule of those individuals are performed again. Some of repeat line cracks, consequently fuzzy rule tables of a navigation fuzzy control module are transposed to the fuzzy rule of the obtained individual until a favorite navigation property is acquired or the above processing reaches a convention generation number, and an accumulating-totals table is initialized by 0 (step 2-13). Then, the accumulating totals of the goodness of fit of each fuzzy rule at this time are searched for until it will perform fuzzy control using the replaced fuzzy rule table and will change to evolution mode again, if it usually changes to the control mode. By repeating the above-mentioned processing, the accumulating totals of a goodness of fit are expensive. In order not to change the fuzzy rule of the field which becomes possible [optimizing intensively about the fuzzy rule of the field which may set by current environment and is used], and is seldom used, Environment changes suddenly, and even when the fuzzy rule of the field currently seldom used is used, it becomes possible to perform stable control.

[0009] 2. The control trim control module in an acceleration optimization control section outputs the trim variation to speed. Drawing 11 is a graph which shows the relation between the speed-system head curve of a marine vessel, and a trim location. As shown in drawing 11 , the speed-system head curve of a marine vessel changes greatly with trim locations. The resistance

generated between a flying-boat hull and the water surface can roughly be divided into wave making resistance and frictional resistance. Wave making resistance is resistance by the wave which oneself generates at the time of propulsion of a marine vessel, and frictional resistance is resistance generated by friction with a flying-boat hull and the water surface. In a low-speed region, wave making resistance increases as it accelerates, and in a certain speed, it becomes a limit. This condition is called a hump, and a hump becomes large gradually as it is the smallest and approaches the full trim out whose angle of trim is in the biggest condition, when it is the full trim in which is in the condition that an angle of trim is the smallest." If a hump is exceeded, wave making resistance becomes small gradually and will be in a play NINGU condition soon. The frictional resistance at the time of play NINGU is the largest at the time of full trim in, and becomes the smallest near full trim out at it. Usually, when accelerating from the time of a stop to full speed manually, a throttle is made full admission from the condition of full trim in, and it is operated to an out side from the event of exceeding a hump to the angle of trim in which pitching and the Dutch roll do not generate a trim gradually. pressing down wave making resistance and frictional resistance by carrying out like this — possible — becoming — as a result — the time of a stop — oh, time amount until it reaches full speed is shortened. However, the class of flying-boat hull changes greatly with disturbance, and an angle of trim final in the timing which operates a trim, and the speed list to operate requires advanced actuation technology. The genetic algorithm is used for the autonomous mold evolution processing section in the acceleration optimum-control section, as shown in drawing 12 , it codes the control parameter (whenever [trim out initial speed T1, trim actuation speed T2, and last angle-of-trim] T3) of a trim control module, generates an individual, and it optimizes these control parameters using a genetic algorithm. The acceleration property that assessment of the each object under autonomous mold evolution processing serves as an aim For example, so that time amount until it reaches the speed defined from the time of a stop is short It is constituted so that the assessment section set up so that an assessment value might become high may carry out, consequently the control parameter of a trim control module is automatically optimized towards the acceleration property used as an aim, and when an operating environment and a flying-boat hull change, the optimal acceleration property comes to be acquired. Moreover, the genetic algorithm is used for the interactive evolution processing section in the acceleration optimum-control section, and it codes the control parameter of a trim control module, generates an individual, and optimizes these control parameters using a genetic algorithm. It is constituted so that a user may perform assessment of the each object under interactive optimization processing based on the degree of comfort felt actually, consequently the control parameter of a trim control module is optimized according to assessment of a user, and the optimal acceleration property suitable for assessment of a user comes to be acquired. The change of the autonomous mold evolution processing section and the interactive evolution processing section may be performed based on a user's intention through an interface as performed based on the conditions defined beforehand, for example, time amount, and shown in drawing 7 . Based on the optimal acceleration property which performed evolution processing in the autonomous mold evolution processing section first, and was specifically acquired there When an individual which performs evolution processing in the interactive evolution processing section, may constitute so that liking of a user may be suited and it may tune finely, and does not enter during autonomous mold evolution processing at a user's mind occurs, a user may give the assessment value 0 on that spot, and you may constitute so that it may change to degree individual. Next, the evolution processing in the above-mentioned acceleration optimum-control section is explained. Drawing 13 is a flow chart which shows the flow of evolution processing of an acceleration optimization control section.

a. As shown in evolution processing drawing 13 in the autonomous mold evolution processing section, determine at random in the range which was able to determine the initial value of a control parameter beforehand first, and generate the 1st certain generation from two or more initial individuals (step 1-1). And acceleration optimum-control assessment to all the individuals of the 1st generation is performed (step 1-2). Here, if acceleration optimum-control assessment is explained briefly, time amount until it accelerates at full throttle to the speed defined from the

stop condition and reaches the defined speed once per one individual will be computed as an assessment value. Based on the assessment blood of the each object acquired by the above-mentioned assessment value computation (step 1-2), it evaluates whether it is the optimal acceleration property (step 1-3), and judges whether the optimal acceleration property has been acquired as a result of assessment (step 1-4). And when the optimal navigation property is acquired, evolution processing is ended, when not obtained, it goes into an evolution mold count module, and a next-generation individual county is generated (step 1-5).
b. As shown in evolution processing drawing 13 in the interactive evolution processing section, determine at random in the range which was able to determine the initial value of a control parameter beforehand first, and generate the 1st generation which consists of two or more initial individuals (step 1-2). And it test-rides using the parameter of which [of the 1st generation] individual (step 2-2), and a user inputs the assessment value over the individual (step 2-3). When it judges whether the favorite acceleration property was acquired (step 2-4) and it is judged based on said assessment value that it was obtained, evolution processing is ended, and when not obtained, it judges whether a trial ride and assessment were completed to all the individuals of one generation (step 2-5). When the trial ride and assessment to all individuals are not completed, the parameter of a trim control module is changed into the thing of another individual (step 2-6), and it is made to test-ride again (step 2-2). Moreover, when the trial ride and assessment to all individuals are completed, it goes into an evolution mold count module (step 2-7), and a next-generation individual county is generated, again, it swerves and the trial ride and assessment using a parameter of that individual are performed. The parameter of a repeat line crack, consequently a trim control module is optimized until the acceleration property of liking [these processings] is acquired. Here, if assessment of the acceleration property which adopted the interactive mode is explained, once per one individual, it will accelerate at full throttle to the speed defined from the stop condition, and an assessment value will be inputted based on the feeling of acceleration and degree of comfort which the user felt.
[0010] Here, some examples of an evolution mold count module are explained.
a. Genetic algorithm (GA)
Drawing 14 is the outline flowchart of the evolution mold count module at the time of using a genetic algorithm as an evolution mold numerical orientation method. By this module, after the termination of assessment of all individuals of one generation, when a favorite property is acquired and it swarms, a next-generation individual county is generated. About a scaling (step 1), linear transform of fitness is performed so that the ratio of the maximum fitness in an individual county and average fitness may become fixed. About selection (step 2), the roulette selection method chosen probable in proportion to a user's assessment value (fitness) may be adopted. Moreover, the tournament selection which chooses a thing with the best assessment value in n individuals chosen at random can also be used. There is technique, such as one-point decussation, two-point decussation, or normal distribution decussation, in decussation (step 3). In addition, although that the parents chosen for decussation are the same individuals can also start, since the versatility as an individual county will be lost when this is left, when the parents chosen as decussation are the same individuals, it changes for the individual as which others were chosen, and decussation of the same possible individual is avoided. About mutation (step 4), it is probability fixed about each locus of an individual, and a value is changed at random. The method of adding the perturbation which follows a normal distribution in addition to this is also considered. In spite of having chosen a different individual as parents of decussation, mutation is produced in probability higher than usual about both parents whom it sees hereditarily, and they intersect in being completely the same. Moreover, the technique of the alternation of generations called "playback" which replaces all the individuals of time cost other than the above at once may be used. Furthermore, since there is a possibility of destroying the high individual of assessment when an alternation of generations is applied strictly, the elite conservation strategy of leaving the elite (a number of arbitration of individuals which gained high assessment) unconditionally to the next generation may be doubled and used.
b. Evolution strategy (ES)
Drawing 15 is the outline flowchart of the evolution mold count module at the time of using an

evolution strategy as an evolution mold numerical orientation method. By this module, after the termination of assessment of all individuals of one generation, when a favorite property is not acquired, a next-generation individual county is generated. Since the method of selection changes with classes of evolution strategy about selection (step 1), two kinds of typical technique is explained here. In the case of the evolution strategy called (mu, lambda)-ES, mu individual is definitely chosen sequentially from the good thing of fitness from the child individuals of lambda individual generated from the parent individual of mu individual. (Micro+lambda) In the case of the evolution strategy called -ES, mu individual is definitely chosen sequentially from the good thing of fitness from the individual counties with which the parent individual of mu individual and the child individual of lambda individual were doubled. There is the following technique other than the above in an evolution strategy, and in using these, it performs the method of the selection doubled with such technique.

- -ES : (1 One) Random walk (RW)

- -ES : (1+1) Hill climbing (HC)

- -ES, heuristics near (1+lambda)-ES: and (mu+1) -ES : (1 lambda) Although normal distribution decussation is used about continuation generation mold multipoint heuristics decussation (step 2), it is good in inheriting parents' value for every parameter also considering the middle point, an internally dividing point, or an externally dividing point as a child's value. About mutation (step 3), the perturbation which follows a normal distribution to each parameter is added. At this time, distribution of a normal distribution may adjust for every parameter, and may give correlation between parameters. As explained above, since each parameter is used for an evolution strategy (ES) with a real number value, it has the advantage that the conversion to genotype from phenotype like a genetic algorithm becomes unnecessary. Moreover, parents' characteristic can be made to reflect strongly in a child's characteristic the binary code and Gray code which may set to a genetic algorithm and are used by using the decussation method in consideration of the continuity of the real numbers, such as normal distribution decussation, rather than one-point decussation or the thing which carries out multipoint decussation.

c. Evolutional programming (EP)

Drawing 16 is the outline flowchart of the evolution mold count module at the time of using evolutional programming as the evolution mold count technique. Let the number which won [individual / of 2micro individual which doubled the individual after adding an individual and a perturbation before adding a perturbation when a population was mu individual] about the scaling (step 1) as compared with q individuals chosen as random, respectively be the goodness of fit of the individual. Selection (step 2) chooses mu individual sequentially from the good thing of fitness from the generated individual counties. Although selection is deterministic, since the scaling is probable, selection becomes probable substantially. Evolutional programming (EP) explained above has the advantage that the change to genotype from phenotype like a genetic algorithm becomes unnecessary in order to use each parameter with a real number value. Moreover, since decussation is not used, there is no constraint in phenotype. ******, the tree structure, etc. are sufficient as the need that a genetic algorithm makes a parameter the shape of a string like an evolution strategy.

[0011] Since an operating environment is remarkably changed by change of the weather or a season and liking of a user is also changed remarkably, the planing boat explained by this example Since it is an impossible controlled system substantially to acquire the vessel speed control characteristic all users can be satisfied with the bottom of all operating environments of the control characteristic in the phase of layout or the phase of setting before shipment and an outboard motor and a hull are usually manufactured separately, Although it is dramatically difficult to optimize the property of a fuzzy control machine according to all conditions when the throttle control and angle-of-trim control which were doubled with the hull are needed in addition to the property of an operating environment and a user and the fuzzy control machine is used for the control unit in order to perform optimal vessel speed control By constituting so that the parameter of the navigation fuzzy control module of the control unit 10 which controls electronic throttle-valve actuation and a trim adjustment can be optimized in the real time using evolution mold count, as explained above The remarkable effect of becoming possible to perform

vessel speed control suitable for all these conditions is done so.
[0012] By inputting information, such as an engine speed, speed, acceleration, and a steering angle, and operating an electronic throttle valve and a trimming gear in the example explained above, based on these input Fixed-speed sailing control is performed by controlling the position of an inhalation air content and a flying-boat hull. A fixed-speed sailing control section Based on predetermined input, a navigation fuzzy control module determines the opening of an electronic throttle valve, and whenever [angle-of-trim]. The normalization coefficient of said navigation fuzzy control module is optimized using autonomous mold assessment. By optimizing the fuzzy rule of said navigation fuzzy control module using interactive assessment, and inputting speed, and operating a trimming gear based on input Acceleration control is performed by controlling a position. The acceleration optimum-control section Although the sailing control unit which determined whenever [angle-of-trim] with the trim control module based on predetermined input, and optimized the control parameter of said trim control module using autonomous mold assessment and interactive assessment is explained A sailing control unit to this invention, without being limited in the above-mentioned example For example, you may constitute so that assessment may be performed based on fuel consumption specific consumption and/or power consumption, and you may carry out based on a user's degree of comfort and an acceleration optimization control section may be equipped with an electronic throttle control module. Moreover, although it consists of above-mentioned examples so that it may optimize about the outboard motor and trimming gear of a planing boat Without being limited to this example, as shown in drawing 17 , this, for example The engine and water nozzle trimming gear in personal water Kraft used as a combination finished product combining an engine and a water nozzle trimming gear, and a flying-boat hull are used as an unit. When this invention is applied, the property as personal water Kraft is optimized for the control unit which controls the electronic throttle-valve equipment and the water nozzle trimming gear in an engine as an error criterion. As it becomes possible to optimize control of the position of an inhalation air content and a flying-boat hull and is shown in drawing 18 The outboard motor and trimming gear in the planing boat used as a combination finished product combining a flying-boat hull, and the outboard motor and trimming gear which carried the gasoline engine are used as an unit. It becomes possible to optimize the property of a planing boat for the control unit which controls the electronic throttle-valve equipment and the trimming gear in an engine as an error criterion, and to optimize control of the position of an inhalation air content and a flying-boat hull, when this invention is applied. furthermore, as shown in drawing 19 , in offering this invention by using as an unit the outboard motor and flap mobile in the planing boat used as a combination finished product combining a flying-boat hull, and the outboard motor and flap mobile which carried the diesel power plant It becomes possible to optimize the property of a planing boat for the control unit which controls the fuel injection equipment and flap mobile in an engine as an error criterion, and to optimize control of the position of fuel oil consumption and a flying-boat hull.
[0013]
[Effect of the Invention] In the marine vessel equipped with the equipment with which this invention affects a sailing property as explained above The sailing property control unit equipped with the control module which opts for the output about the control input of the equipment which affects said sailing property based on predetermined input is formed, and the property as a marine vessel is made applicable to assessment at said sailing property control unit. In the real time Since the optimization processing section which optimizes said control module is prepared, the effect of becoming possible to acquire the optimal sailing property which suited liking and operating environment of the user who is various and is easy to change each time is done so. Since the class of flying-boat hull separate from a flying-boat hull which is manufactured and is attached is also various, and liking of a user, and not only an operating environment but suitability with a flying-boat hull are also required, it is dramatically difficult to acquire the property which suited all, but since the equipment which affects said sailing property is an outboard motor according to invention concerning claim 2, an outboard motor does so the effect that a trouble which was described above is cancelable. Moreover, since said optimization processing section performs assessment about optimization processing based on the error

criterion set up beforehand according to invention concerning claim 10, the effect of not applying the burden about optimization processing to a user is done so. Since according to invention concerning claim 11 said optimization processing section is equipped with a means to input the assessment based on the user intention about optimization processing and optimizes along with the assessment based on said user intention further again Since liking of a user can be made to reflect in optimization processing, the property which suited liking of a user more can be acquired, and the effect that he can give a user the pleasure of having participated in optimization is done so.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline block diagram showing one example of the sailing property control unit concerning this invention.
[Drawing 2] It is the schematic diagram showing the relation between an outboard motor and a trimming gear, and a control unit.
[Drawing 3] It is the outline block diagram showing the internal configuration of a control unit 10.
[Drawing 4] It is the outline block diagram showing the internal configuration of a control unit 10.
[Drawing 5] It is drawing showing notionally the relation between the normalization coefficient of a navigation fuzzy control module, and the individual which coded it and was generated.
[Drawing 6] It is drawing showing notionally the relation between the fuzzy rule table of a navigation fuzzy control module, and the individual which coded the part and was generated.
[Drawing 7] It is the flow chart which shows the flow of evolution processing of a fixed-speed sailing control section.
[Drawing 8] It is the graph which shows an example of the method of time sharing in case time sharing estimates two or more individuals.
[Drawing 9] Usually, it is drawing showing an example of an interface which performs a switch in the control mode and evolution mode.
[Drawing 10] It is drawing showing an example of how to search for the accumulating totals of the goodness of fit of a fuzzy rule.
[Drawing 11] It is the graph which shows the relation between the speed-system head curve of a marine vessel, and a trim location.
[Drawing 12] It is drawing showing an example of the individual used in the autonomous mold evolution processing section in the acceleration optimum-control section.
[Drawing 13] It is the flow chart which shows the flow of evolution processing of an acceleration optimization control section.
[Drawing 14] It is the outline flowchart of the evolution mold count module at the time of using a genetic algorithm as an evolution mold numerical orientation method.
[Drawing 15] It is the outline flowchart of the evolution mold count module at the time of using an evolution strategy as an evolution mold numerical orientation method.
[Drawing 16] It is the outline flowchart of the evolution mold count module at the time of using evolutional programming as the evolution mold count technique.
[Drawing 17] It is the schematic diagram showing another example of application of this invention.
[Drawing 18] It is the schematic diagram showing still more nearly another example of application of this invention.
[Drawing 19] It is the schematic diagram showing still more nearly another example of application of this invention.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] The sailing property control unit which forms the sailing property control unit equipped with the control module which opts for the output about the control input of the equipment which affects said sailing property based on predetermined input in the vessel equipped with the equipment which affects a sailing property, and is characterized by making the property as a vessel applicable to evaluation at said sailing property control unit by to prepare the optimization-processing section which optimizes said control module in the real time.
[Claim 2] The sailing property control unit according to claim 1 characterized by said sailing property control unit being a control unit which controls the operating characteristic of said prime mover including the outboard motor with which the equipment which affects said sailing property was equipped with the prime mover.
[Claim 3] The sailing property control unit according to claim 2 characterized by equipping said prime mover with electronic throttle equipment and/or an electronics control fuel injection equipment, and said control unit controlling whenever [electronic throttle valve-opening], and/or fuel oil consumption.
[Claim 4] A sailing property control unit given in any 1 term of claims 1-3 characterized by said sailing property control unit being a control unit which controls whenever [angle-of-trim / of said trimming gear] including the outboard motor with which the equipment which affects said sailing property was equipped with the trimming gear.
[Claim 5] The sailing property control unit according to claim 1 characterized by the equipment which affects said sailing property being a control unit with which said sailing property control unit controls the operating characteristic of said prime mover including the prime mover formed in **.
[Claim 6] The sailing property control unit according to claim 5 characterized by equipping said prime mover with electronic throttle equipment and/or an electronics control fuel injection equipment, and said control unit controlling whenever [electronic throttle valve-opening], and/or fuel oil consumption.
[Claim 7] A sailing property control unit given in any 1 term of claims 1-6 characterized by said sailing property control unit being a control unit which controls the operating characteristic of working flap equipment at least including the working flap equipment with which the equipment which affects said sailing property is attached in a flying-boat hull.
[Claim 8] A sailing property control unit given in any 1 term of claims 5-8 characterized by for said prime mover being a prime mover for generating the stream for generating driving force, and the equipment which affects said sailing property being a control unit with which said sailing property control unit controls the operating characteristic of said water nozzle trimming gear at least including the water nozzle trimming gear which can change the sense of said stream.
[Claim 9] A sailing property control device given in any 1 term of claims 1-7 characterized by being constituted so that the control input of the equipment with which the control module in said sailing property control device affects said sailing property may be outputted and the optimization processing section may optimize the control parameter of said control module.
[Claim 10] The basic control module with which the control module in said sailing property control device outputs the control input of the equipment which affects said sailing property based on predetermined input, Based on predetermined input, have output **** for the amount of amendments or correction factor to said control input, and it has a control module for amendment. A sailing property control unit given in any 1 term of claims 1-7 characterized by constituting said optimization processing section so that the control parameter of said control module for amendment

may be optimized.
[Claim 11] A sailing property control unit given in any 1 term of claims 1-10 characterized by having the optimization operation part to which said optimization processing section performs the operation about an optimization technique, and the autonomous mold evaluation section which performs evaluation about optimization processing based on the valuation basis set up beforehand.
[Claim 12] A sailing property control unit given in any 1 term of claims 1-10 characterized by equipping said optimization processing section with the optimization operation part which performs the operation about an optimization technique, and a means to input the evaluation based on the user intention about optimization processing, and optimizing along with the evaluation based on said user intention.
[Claim 13] A sailing property control unit given in any 1 term of claims 9-12 to which said predetermined input is characterized by including at least any of boat speed, ******, ****, a steering angle, a throttle control input, or an engine speed they are.
[Claim 14] A sailing property control unit given in any 1 term of claims 1-13 to which the property as a vessel used as said candidate for evaluation is characterized by including specific fuel consumption and/or power consumption at least.
[Claim 15] A sailing property control unit given in any 1 term of claims 1-14 characterized by including the flattery nature of fixed-speed sailing control to the boat speed which time amount until the property as a vessel used as said candidate for evaluation reaches full speed from the time of a stop at least, and/or a user specified.
[Claim 16] A sailing property control unit given in any 1 term of claims 1-15 to which the property as a vessel used as said candidate for evaluation is characterized by being the degree of comfort of a vessel at least.
[Claim 17] A sailing property control unit given in any 1 term of claims 1-16 characterized by being constituted so that said optimization evaluation section may perform the operation about optimization using heuristics.
[Claim 18] The sailing property control unit according to claim 17 characterized by said heuristics being evolution mold calculus.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the sailing property control unit which enables optimal sailing according to a user's liking, an operating environment, etc.
[0002]
[Description of the Prior Art] It ****, where the outboard motor used from the former, being attached in the posterior part of a flying-boat hull is attached in a flying-boat hull before shipment, and setting of the property of the engine and trimming gear is performed.
[0003]
[Problem(s) to be Solved by the Invention] However, since an operating environment is remarkably changed by change of the weather or a season and liking of a user is also changed remarkably, a vessel is usually difficult to set the engine and trimming gear of an outboard motor so that the sailing property all users can be satisfied with the bottom of all operating environments of a property may be acquired. For this reason, it does not restrict that the property set in the phase of **** since the time of setting differs from a loading condition when actually using a vessel, and disturbance, such as a wave, was also received and the time of setting differed from an operating environment remarkably in many cases is not necessarily the optimal, but it may be sensed to a user depending on the case that it is uncomfortable to ride in. Such a trouble is common not only for the vessel of the type carrying an outboard motor but the vessel which carried the prime mover in ** and the vessel furnished with working flap equipment. This invention solves the above-mentioned conventional trouble, and aims at offering the sailing property control unit which enables optimal sailing according to a user's liking, an operating environment, etc.
[0004]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the sailing property control unit concerning this invention The sailing property control unit equipped with the control module which opts for the output about the control input of the equipment which affects said sailing property based on predetermined input in the vessel equipped with the equipment which affects a sailing property is formed. It is characterized by preparing the optimization processing section which is the real time and optimizes said control module by making the property as a vessel applicable to evaluation at said sailing property control device.
[0005]
[Embodiment of the Invention] The gestalt of operation of the sailing property control unit concerning this invention is explained referring to some examples shown in the accompanying drawing hereafter. Drawing 1 is the outline block diagram showing one example of the sailing control device concerning this invention. As shown in a drawing, this sailing control unit made suitable external world information input, based on that input, determined the information about the control input of the equipment which affects a sailing property, and is equipped with the control module to output. Preferably, although this control module may be the control module which has adopted the fuzzy inference system, for example, a fuzzy control machine, a fuzzy decision-making system, or a fuzzy neuro-controller, it is not limited to this. Moreover, this sailing control unit is equipped with the optimization processing section, and it has the interactive evolution processing section and/or the autonomous mold evolution processing section, and by these evolution processing sections, by making the property as a vessel applicable to evaluation, this optimization processing section is the real time, and optimizes the parameter of said control module. As long as the parameter which should be

optimized is a parameter about a control module, the parameter of arbitration is sufficient as it, for example, when the fuzzy inference system is adopted, the standardization multiplier of the parameter for deciding the number, the configuration, the location, and breadth of a member cypripedium function, a fuzzy rule, or an I/O value etc. is mentioned. Moreover, it is carried out about the evaluation for optimization by the evaluation section by which the user was beforehand designed based on the predetermined valuation basis to a direct deed and the autonomous mold evaluation processing section to the interactive evolution processing section. Thus, it becomes possible to fit the property of a vessel to a user's liking and operating environment in the real time with constituting from the real time by making the property as a vessel applicable to evaluation, so that the operating characteristic of the equipment which affects a sailing property can be optimized.

[0006] Next, the example which specified the controlled system for the example of application of the sailing property control unit concerning this invention is given and explained. Drawing 2 - drawing 17 show the example which applied the optimization approach concerning this invention to the outboard motor and trimming gear of a planing boat. Drawing 2 is the schematic diagram showing the relation between an outboard motor and a trimming gear, and a control unit. When liking of the navigation in favorite temporal response, for example, spring, and autumn of the user same [not to mention] when the control unit is shown, and this control unit 10 acquires the optimal navigation property and the acceleration property of realizing change, the fixed-speed air-mail control according to disturbance, and the acceleration optimum control of a flying-boat hull and liking of a user, i.e., a user, differs changes, even if the inside of drawing and a sign 10 respond, they are constituted so that the optimal navigation property and an acceleration property may acquire. In addition, in this example, a "navigation property" means the thing of the vessel speed control characteristic by electronic throttle-valve actuation and the trim adjustment. By inputting information, such as an engine speed, a rate, acceleration, a steering include angle, and throttle opening, and operating an electronic throttle valve and the trimming gear equipped with the oil hydraulic cylinder and the hydraulic pump based on these input, a control device 10 controls the posture of an inhalation air content and a hull, and performs fixed-speed sailing control and an acceleration optimum control.

[0007] Drawing 3 and drawing 4 are the outline block diagrams showing the internal configuration of a control device 10. As shown in a drawing, this control unit 10 has a fixed-speed sailing control section and an acceleration optimization control section. A fixed-speed sailing control section has the navigation fuzzy control module which determines the opening of an electronic throttle valve, and whenever [angle-of-trim] based on predetermined input, the autonomous mold evolution processing section which optimizes the standardization multiplier of said navigation fuzzy control module, the navigation nature evaluation section which performs evaluation of the autonomous mold evolution processing section, and the interactive evolution section which optimizes the fuzzy rule of said navigation fuzzy control module, as shown in drawing 3 . Moreover, an acceleration optimization control section has the trim control module which determines whenever [angle-of-trim] based on predetermined input, the autonomous mold evolution processing section which optimizes the control parameter of said trim control module, the acceleration nature evaluation section which performs evaluation of the autonomous mold evolution processing section, and the interactive evolution processing section which optimizes the control parameter of said trim control module, as shown in drawing 4 . In addition, the above "a standardization multiplier" means the multiplier which adjusts the magnitude of I/O information.

[0008] 1. Control in a fixed-speed sailing control section : as a fuzzy inference system, for example, the simple reasoning method is used for a navigation fuzzy control module, and it outputs [whenever / electronic throttle valve-opening / to an engine speed, a rate, acceleration, and a steering include angle] variation whenever [variation and angle-of-trim]. Said fuzzy rule table may be designed based on an expert's navigation knowledge, and the fuzzy rule in the simple reasoning method is expressed with a real number value. The genetic algorithm is used for the autonomous mold evolution processing section in a fixed-speed sailing control section, as shown in drawing 5 , it codes the standardization multiplier of said navigation fuzzy control module, generates an individual, and it optimizes these standardization multipliers using a genetic algorithm. The navigation property that evaluation of the each object under autonomous mold evolution processing serves as a target For example, it is constituted so that the evaluation section set up so that the deflection of whenever [to the rate which the user defined / real velocity] approached below desired value and an evaluation value might become high may carry out. Consequently, the standardization multiplier of a navigation fuzzy control module is automatically optimized towards the navigation property used as a target, and when an operating environment and a flying-boat hull change, the optimal navigation property comes to be acquired. Thus,

the evaluation section designed beforehand performs evaluation in evolution processing, and autonomous mold evaluation is called for the approach of enabling it to optimize automatically on these specifications. Moreover, the genetic algorithm is used for the interactive evolution processing section in a navigation control section, as shown in drawing 6 , it codes some fuzzy rule tables of said navigation fuzzy control module, generates an individual, and it optimizes some of these fuzzy rule tables using a genetic algorithm. It is constituted so that a user may perform evaluation of the each object under interactive optimization processing based on the actually felt degree of comfort, consequently some fuzzy rule tables of a navigation fuzzy control module are optimized according to evaluation of a user, and the optimal navigation property suitable for evaluation of a user comes to be acquired. Thus, how a user performs evaluation in evolution processing is called interactive evaluation on these specifications. Next, the evolution processing in the above-mentioned fixed-speed sailing control section is explained. Drawing 7 is a flow chart which shows the flow of evolution processing of a fixed-speed sailing control section. As mentioned above, in this control unit, in case evolution processing is performed, autonomous mold evaluation is performed about the autonomous mold evolution processing section of a fixed-speed sailing control section, and interactive evaluation is used about the interactive evolution processing section. Since the flow of optimization processing differs when the evaluation approaches differ, the following explanation divides and explains the evolution processing which adopted the autonomous mold evaluation approach, and the evolution processing which adopted the interactive evaluation approach.

a. As shown in evolution processing drawing 7 in the autonomous mold evolution processing section, determine at random within limits which determined the initial value of a standardization multiplier beforehand first, and generate the 1st generation which consists of two or more initial individuals (step 1-1). And fixed-speed sailing control evaluation to all the individuals of the 1st generation is performed (step 1-2). Here, if fixed-speed sailing control evaluation is explained briefly, two or more individuals are operated in parallel in false by time sharing, and the evaluation value in the sum total of the period is compared. evaluation is changed according to the use region of an engine speed, for example, as shown at drawing 8 in the case of the troll using an engine low rotation region, about ten individuals, it controls every [1] and the absolute value of the difference of whenever [to a target rate / real velocity] is totaled for every sampling time, and specifically, the total indicator within 20 cycle repeat and an evaluation period is computed as an evaluation value by making this into 1 cycle. Since the effect by disturbance, such as the weather and a hydrographic condition (specifically for example, a wind and a wave), is arranged as total with an each object, carrying out like this can estimate the property of an each object impartially. In the case of the cruise using an engine high rotation region, to the above mentioned evaluation approach moreover, in order to control the unstable behavior generated at the time of a high speed, i.e., pitching to which a flying-boat hull shakes up and down, and the Dutch roll shaken at right and left, [in addition,] When pitching or the Dutch roll is detected, 0 is given as an evaluation value of an individual, a flying-boat hull is stabilized by decreasing an angle of trim to the include angle which pitching or the Dutch roll does not generate, and an each object is henceforth evaluated by making the include angle into the maximum angle of trim. By carrying out like this, it can prevent that unstable behavior occurs at the time of a high speed. Based on the evaluation value of the each object acquired by the above-mentioned evaluation value computation (step 1-2), it evaluates whether it is the optimal navigation property (step 1-3), and judges whether the optimal navigation property has been acquired as a result of evaluation (step 1-4). And when the optimal navigation property is acquired, evolution processing is ended, when not obtained, it goes into an evolution mold count module, and a next-generation population is generated (step 1-5).

b. As shown in evolution processing drawing 7 in the interactive evolution processing section, there are usually the control mode and evolution mode in the interactive evolution processing section. Usually, a switch (step 2-1) in the control mode and evolution mode may be performed based on a user's volition through an interface as performed based on the conditions decided beforehand, for example, time amount, and shown in drawing 9 . Usually, in the control mode, fuzzy control is performed using the fuzzy rule table decided at the time, and it asks for the accumulating totals of the goodness of fit of each fuzzy rule until it changes to evolution mode at coincidence (step 2-2). It ends, when it adds to the accumulating-totals table which calculates the accumulating totals of a goodness of fit until it changes the result of an operation of a goodness of fit table which calculates the goodness of fit of each fuzzy rule in a certain time of day to evolution mode (step 2-3) and this is specifically changed to evolution mode, as shown in drawing 10 . If it changes to evolution mode, a number of arbitration of fuzzy rules which correspond to drawing 7 with reference to an accumulating-totals table so that it may be shown will be coded for a chromosome sequentially from the large thing of

accumulating totals (step 2-4), the perturbation which followed normal distribution by making this into initial value will be added, and the 1st generation which consists of two or more initial individuals will be generated (step 2-5). And it test-rides using the parameter of one individual of the 1st generation (step 2-6), and a user inputs the evaluation value over the individual (step 2-7). When it judges whether the favorite navigation property was acquired (step 2-8) and it is judged based on said evaluation value that it was obtained, evolution processing is ended by making the individual into the maximum superior individual, and when not obtained, a trial ride and evaluation judge whether it is the termination method no to all the individuals of one generation (step 2-9). When all individuals and evaluations are not completed, the fuzzy rule of a fuzzy control module is changed into the thing of another individual (step 2-10), and it is made to test-ride again (step 2-6). moreover, when the trial ride and evaluation to all individuals are completed When it judges whether the convention generation number was reached (step 2-11) and it is judged that it reached In the generation, by making an individual with the highest evaluation value into the maximum superior individual, when it ends and it is judged that evolution processing has not reached, it goes into an evolution mold count module (step 2-12), and a next-generation individual county is generated, and the trial ride and evaluation using a fuzzy rule of those individuals are performed again. The above processing is repeatedly performed until a favorite navigation property is acquired or it reaches a convention generation number, consequently some fuzzy rule tables of a navigation fuzzy control module are transposed to the fuzzy rule of the obtained individual, and an accumulating-totals table is initialized by 0 (step 2-13). Then, it asks for the accumulating totals of the goodness of fit of each fuzzy rule at this time until it will perform fuzzy control using the replaced fuzzy rule table and will change to evolution mode again, if it usually changes to the control mode. By repeating the above-mentioned processing, the accumulating totals of a goodness of fit are high. In order not to change the fuzzy rule of the field which becomes possible [optimizing intensively about the fuzzy rule of the field which may set by the current environment and is used], and is seldom used, An environment changes suddenly, and even when the fuzzy rule of the field currently seldom used is used, it becomes possible to perform stable control.
[0009] 2. The control trim control module in an acceleration optimization control section outputs the trim variation to a rate. Drawing 11 is a graph which shows the relation between the rate-system head curve of a vessel, and a trim location. As shown in drawing 11 , the rate-system head curve of a vessel changes greatly with trim locations. The resistance generated between a flying-boat hull and the water surface can roughly be divided into wave making resistance and frictional resistance. Wave making resistance is resistance by the wave which oneself generates at the time of promotion of a vessel, and frictional resistance is resistance generated by friction with a flying-boat hull and the water surface. In a low-speed area, wave making resistance increases as it accelerates, and in a certain rate, it becomes a limit. This condition is called a hump, and a hump becomes large gradually as it is the smallest and approaches the full trim out whose angle of trim is in the biggest condition, when it is the full trim in which is in the condition that an angle of trim is the smallest." If a hump is exceeded, wave making resistance becomes small gradually and will be in a play NINGU condition soon. The frictional resistance at the time of play NINGU is the largest at the time of full trim in, and becomes the smallest near full trim out at it. Usually, when accelerating from the time of a stop to full speed manually, a throttle is made full open from the condition of full trim in, and it is operated to an out side from the time of exceeding a hump to the angle of trim in which pitching and the Dutch roll do not generate a trim gradually. pressing down wave making resistance and frictional resistance by carrying out like this -- possible -- becoming -- as a result -- the time of a stop -- oh, time amount until it reaches full speed is shortened. However, the class of flying-boat hull changes greatly with disturbance, and an angle of trim final in the timing which operates a trim, and the rate list to operate requires an advanced actuation technique. The genetic algorithm is used for the autonomous mold evolution processing section in an acceleration optimization control section, as shown in drawing 12 , it codes the control parameter (whenever [trim out initial speed T1, trim actuation rate T2, and last angle-of-trim] T3) of a trim control module, generates an individual, and it optimizes these control parameters using a genetic algorithm. The acceleration property that evaluation of the each object under autonomous mold evolution processing serves as a target For example, so that time amount until it reaches the rate defined from the time of a stop is short It is constituted so that the evaluation section set up so that an evaluation value might become high may carry out, consequently the control parameter of a trim control module is automatically optimized towards the acceleration property used as a target, and when an operating environment and a flying-boat hull change, the optimal acceleration property comes to be acquired. Moreover, the genetic algorithm is used for the interactive evolution processing section in an acceleration optimization control section, and it codes the control parameter of a trim control module, generates an individual, and optimizes these control parameters using a genetic algorithm. It is constituted so that a user may perform evaluation of the each

object under interactive optimization processing based on the actually felt degree of comfort, consequently the control parameter of a trim control module is optimized according to evaluation of a user, and the optimal acceleration property suitable for evaluation of a user comes to be acquired. The change of the autonomous mold evolution processing section and the interactive evolution processing section may be performed based on a user's intention through an interface as performed based on the conditions defined beforehand, for example, time amount, and shown in drawing 7 . Based on the optimal acceleration property which performed evolution processing in the autonomous mold evolution processing section first, and was specifically acquired there When an individual which performs evolution processing in the interactive evolution processing section, may constitute so that liking of a user may be suited and it may tune finely, and does not enter during autonomous mold evolution processing at a user's mind occurs, a user may give the evaluation value 0 on that spot, and you may constitute so that it may change to degree individual. Next, the evolution processing in the above-mentioned acceleration optimization control section is explained. Drawing 13 is a flow chart which shows the flow of evolution processing of an acceleration optimization control section.
a. As shown in evolution processing drawing 13 in the autonomous mold evolution processing section, determine at random in the range which was able to determine the initial value of a control parameter beforehand first, and generate the 1st certain generation from two or more initial individuals (step 1-1). And acceleration optimization control evaluation to all the individuals of the 1st generation is performed (step 1-2). Here, if acceleration optimization control evaluation is explained briefly, time amount until it accelerates at full throttle to the rate defined from the stop condition and reaches the defined rate once per one individual will be computed as an evaluation value. Based on the evaluation blood of the each object acquired by the above-mentioned evaluation value computation (step 1-2), it evaluates whether it is the optimal acceleration property (step 1-3), and judges whether the optimal acceleration property has been acquired as a result of evaluation (step 1-4). And when the optimal navigation property is acquired, evolution processing is ended, when not obtained, it goes into an evolution mold count module, and a next-generation individual county is generated (step 1-5).
b. As shown in evolution processing drawing 13 in the interactive evolution processing section, determine at random in the range which was able to determine the initial value of a control parameter beforehand first, and generate the 1st generation which consists of two or more initial individuals (step 1-2). And it test-rides using the parameter of which [of the 1st generation] individual (step 2-2), and a user inputs the evaluation value over the individual (step 2-3). When it judges whether the favorite acceleration property was acquired (step 2-4) and it is judged based on said evaluation value that it was obtained, evolution processing is ended, and when not obtained, it judges whether a trial ride and evaluation were completed to all the individuals of one generation (step 2-5). When the trial ride and evaluation to all individuals are not completed, the parameter of a trim control module is changed into the thing of another individual (step 2-6), and it is made to test-ride again (step 2-2). Moreover, when the trial ride and evaluation to all individuals are completed, it goes into an evolution mold count module (step 2-7), and a next-generation individual county is generated, again, it swerves and the trial ride and evaluation using a parameter of that individual are performed. These processings are repeatedly performed until a favorite acceleration property is acquired, consequently the parameter of a trim control module is optimized. Here, if evaluation of the acceleration property which adopted the interactive mode is explained, once per one individual, it will accelerate at full throttle to the rate defined from the stop condition, and an evaluation value will be inputted based on the feeling of acceleration and degree of comfort which the user felt.
[0010] Here, some examples of an evolution mold count module are explained.
a. Genetic algorithm (GA)
Drawing 14 is the outline flowchart of the evolution mold count module at the time of using a genetic algorithm as evolution mold calculus. By this module, after the termination of evaluation of all individuals of one generation, when a favorite property is acquired and it swarms, a next-generation individual county is generated. About a scaling (step 1), linear transformation of fitness is performed so that the ratio of the maximum fitness in an individual county and average fitness may become fixed. About selection (step 2), the roulette selection method chosen probable in proportion to a user's evaluation value (fitness) may be adopted. Moreover, the tournament selection which chooses a thing with the best evaluation value in n individuals chosen at random can also be used. There is technique, such as one-point decussation, two-point decussation, or normal-distribution decussation, in decussation (step 3). In addition, although that the parents chosen for decussation are the same individuals can also start, since the versatility as an individual county will be lost when this is left, when the parents chosen as decussation are the same individuals, it

changes for the individual as which others were chosen, and decussation of the same possible individual is avoided. About mutation (step 4), it is a probability fixed about each locus of an individual, and a value is changed at random. The method of adding the perturbation which follows normal distribution in addition to this is also considered. In spite of having chosen a different individual as parents of decussation, mutation is produced in a probability higher than usual about both parents whom it sees hereditarily, and they intersect in being completely the same. Moreover, the technique of the alternation of generations called "playback" which replaces all the individuals of time cost other than the above at once may be used. Furthermore, since there is a possibility of destroying the high individual of evaluation when an alternation of generations is applied strictly, the elite preservation strategy of leaving the elite (a number of arbitration of individuals which gained high evaluation) unconditionally to the next generation may be doubled and used.

b. Evolution strategy (ES)

Drawing 15 is the outline flowchart of the evolution mold count module at the time of using an evolution strategy as evolution mold calculus. By this module, after the termination of evaluation of all individuals of one generation, when a favorite property is not acquired, a next-generation individual county is generated. Since the method of selection changes with classes of evolution strategy about selection (step 1), two kinds of typical technique is explained here. In the case of the evolution strategy called (mu, lambda)-ES, mu individual is definitely chosen sequentially from the good thing of fitness from the child individuals of lambda individual generated from the parent individual of mu individual. (Micro+lambda) In the case of the evolution strategy called -ES, mu individual is definitely chosen sequentially from the good thing of fitness from the individual counties with which the parent individual of mu individual and the child individual of lambda individual were doubled. There is the following technique other than the above in an evolution strategy, and in using these, it performs the method of the selection doubled with such technique.

- 1 1-ES : random walk (RW)
- 1+1-ES : hill climbing (HC)
- 1, lambda-ES, heuristics near (1+lambda)-ES: and (mu+1) -ES : although normal-distribution decussation is used about continuation generation mold multipoint heuristics decussation (step 2), it is good in inheriting parents' value for every parameter also considering the middle point, an internally dividing point, or an externally dividing point as a child's value. About mutation (step 3), the perturbation which follows normal distribution to each parameter is added. At this time, distribution of normal distribution may adjust for every parameter, and may give correlation between parameters. As explained above, since each parameter is used for an evolution strategy (ES) with a real number value, it has the advantage that the conversion to genotype from phenotype like a genetic algorithm becomes unnecessary. Moreover, parents' characteristic can be made to reflect strongly in a child's characteristic the binary code and Gray code which may set to a genetic algorithm and are used by using the decussation approach in consideration of the continuity of the real numbers, such as normal-distribution decussation, rather than one-point decussation or the thing which carries out multipoint decussation.

c. Evolutional programming (EP)

Drawing 16 is the outline flowchart of the evolution mold count module at the time of using evolutional programming as the evolution mold count technique. Let the number which won [individual / of 2micro individual which doubled the individual after adding an individual and a perturbation before adding a perturbation when a population was mu individual] about the scaling (step 1) as compared with q individuals chosen as random, respectively be the goodness of fit of the individual. Selection (step 2) chooses mu individual sequentially from the good thing of fitness from the generated individual counties. Although selection is deterministic, since the scaling is probable, selection becomes probable substantially. Evolutional programming (EP) explained above has the advantage that the change to genotype from phenotype like a genetic algorithm becomes unnecessary in order to use each parameter with a real number value. Moreover, since decussation is not used, there is no constraint in phenotype. ******, the tree structure, etc. are sufficient as the need that a genetic algorithm makes a parameter the shape of a string like an evolution strategy.

[0011] Since an operating environment is remarkably changed by change of the weather or a season and liking of a user is also changed remarkably, the planing boat explained by this example Since it is an impossible controlled system substantially to acquire the vessel speed control characteristic all users can be satisfied with the bottom of all operating environments of the control characteristic in the phase of a design or the phase of setting before shipment and an outboard motor and a hull are usually manufactured separately, Although it is very difficult to optimize the property of a fuzzy control machine according to all conditions when the throttle control and angle-of-trim control which were

doubled with the hull are needed in addition to the property of an operating environment and a user and the fuzzy control machine is used for the control device in order to perform optimal vessel speed control By constituting so that the parameter of the navigation fuzzy control module of the control device 10 which controls electronic throttle-valve actuation and a trim adjustment can be optimized in the real time using evolution mold count, as explained above The remarkable effectiveness of becoming possible to perform vessel speed control suitable for all these conditions is done so.

[0012] By inputting information, such as an engine speed, a rate, acceleration, and a steering include angle, and operating an electronic throttle valve and a trimming gear in the example explained above, based on these input Fixed-speed sailing control is performed by controlling the posture of an inhalation air content and a flying-boat hull. A fixed-speed sailing control section Based on predetermined input, a navigation fuzzy control module determines the opening of an electronic throttle valve, and whenever [angle-of-trim]. The standardization multiplier of said navigation fuzzy control module is optimized using autonomous mold evaluation. By optimizing the fuzzy rule of said navigation fuzzy control module using interactive evaluation, and inputting a rate, and operating a trimming gear based on input Acceleration control is performed by controlling a posture. An acceleration optimization control section Although the sailing control unit which determined whenever [angle-of-trim] with the trim control module based on predetermined input, and optimized the control parameter of said trim control module using autonomous mold evaluation and interactive evaluation is explained A sailing control unit to this invention, without being limited in the above-mentioned example For example, you may constitute so that evaluation may be performed based on fuel consumption specific consumption and/or power consumption, and you may carry out based on a user's degree of comfort and an acceleration optimization control section may be equipped with an electronic throttle control module. Moreover, although it consists of above-mentioned examples so that it may optimize about the outboard motor and trimming gear of a planing boat Without being limited to this example, as shown in drawing 17 , this, for example The engine and water nozzle trimming gear in personal water Kraft used as a combination finished product combining an engine and a water nozzle trimming gear, and a flying-boat hull are used as an unit. When this invention is applied, the property as personal water Kraft is optimized for the control unit which controls the electronic throttle valve gear and water nozzle trimming gear in an engine as a valuation basis. As it becomes possible to optimize control of the posture of an inhalation air content and a flying-boat hull and is shown in drawing 18 The outboard motor and trimming gear in the planing boat used as a combination finished product combining a flying-boat hull, and the outboard motor and trimming gear which carried the gasoline engine are used as an unit. It becomes possible to optimize the property of a planing boat for the control unit which controls the electronic throttle valve gear and trimming gear in an engine as a valuation basis, and to optimize control of the posture of an inhalation air content and a flying-boat hull, when this invention is applied. furthermore, as shown in drawing 19 , in offering this invention by using as an unit the outboard motor and flap mobile in the planing boat used as a combination finished product combining a flying-boat hull, and the outboard motor and flap mobile which carried the diesel power plant It becomes possible to optimize the property of a planing boat for the control unit which controls the fuel injection equipment and flap mobile in an engine as a valuation basis, and to optimize control of the posture of fuel oil consumption and a flying-boat hull.

[0013]

[Effect of the Invention] In the vessel equipped with the equipment with which this invention affects a sailing property as explained above The sailing property control unit equipped with the control module which opts for the output about the control input of the equipment which affects said sailing property based on predetermined input is formed, and the property as a vessel is made applicable to evaluation at said sailing property control unit. In the real time Since the optimization processing section which optimizes said control module is prepared, the effectiveness of becoming possible to acquire the optimal sailing property which suited liking and operating environment of the user who is various and is easy to change each time is done so. Since the class of flying-boat hull separate from a flying-boat hull which is manufactured and is attached is also various, and liking of a user, and not only an operating environment but compatibility with a flying-boat hull are also required, it is very difficult to acquire the property which suited all, but since the equipment which affects said sailing property is an outboard motor according to invention concerning claim 2, an outboard motor does so the effectiveness that a trouble which was described above is cancelable. Moreover, since said optimization processing section performs evaluation about optimization processing based on the valuation basis set up beforehand according to invention concerning claim 10, the effectiveness of not applying the burden about optimization processing to a user is done so. Since according to invention concerning claim 11 said optimization

processing section is equipped with a means to input the evaluation based on the user intention about optimization processing and optimizes along with the evaluation based on said user intention further again Since liking of a user can be made to reflect in optimization processing, the property which suited liking of a user more can be acquired, and the effectiveness that he can give a user the pleasure of having participated in optimization is done so.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the sailing property control unit which enables optimal sailing according to a user's liking, an operating environment, etc.

[Translation done.]

PRIOR ART

[Description of the Prior Art] It ****, where the outboard motor used from the former, being attached in the posterior part of a flying-boat hull is attached in a flying-boat hull before shipment, and setting of the property of the engine and trimming gear is performed.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] The sailing property control unit equipped with the control module which opts for the output about the control input of the equipment which affects said sailing property based on predetermined input formed, and the optimization-processing section which optimizes said control module in the real time has prepared by making the property as a vessel applicable to evaluation in said sailing property control unit in the vessel equipped with the equipment which affects a sailing property in this invention as explained above. Therefore, the effectiveness of it being various and becoming possible to acquire the optimal sailing property which suited liking and operating environment of the user who is easy to change each time is done so. Since the class of flying-boat hull separate from a flying-boat hull which is manufactured and is attached is also various, and liking of a user, and not only an operating environment but compatibility with a flying-boat hull are also required, it is very difficult to acquire the property which suited all, but since the equipment which affects said sailing property is an outboard motor according to invention concerning claim 2, an outboard motor does so the effectiveness that a trouble which was described above is cancelable. Moreover, since said optimization processing section performs evaluation about optimization processing based on the valuation basis set up beforehand according to invention concerning claim 10, the effectiveness of not applying the burden about optimization processing to a user is done so. Since according to invention concerning claim 11 said optimization processing section is equipped with a means to input the evaluation based on the user intention about optimization processing and optimizes along with the evaluation based on said user intention further again, Since liking of a user can be made to reflect in optimization processing, the property which suited liking of a user more can be acquired, and the effectiveness that he can give a user the pleasure of having participated in optimization is done so.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, since an operating environment is remarkably changed by change of the weather or a season and liking of a user is also changed remarkably, a vessel is usually difficult to set the engine and trimming gear of an outboard motor so that the sailing property all users can be satisfied with the bottom of all operating environments of a property may be acquired. For this reason, it does not restrict that the property set in the phase of **** since the time of setting differs from a loading condition when actually using a vessel, and disturbance, such as a wave, was also received and the time of setting differed from an operating environment remarkably in many cases is not necessarily the optimal, but it may be sensed to a user depending on the case that it is uncomfortable to ride in. Such a trouble is common not only for the vessel of the type carrying an outboard motor but the vessel which carried the prime mover in ** and the vessel furnished with working flap equipment. This invention solves the above-mentioned conventional trouble, and aims at offering the sailing property control unit which enables optimal sailing according to a user's liking, an operating environment, etc.

[Translation done.]

MEANS

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the sailing property control unit concerning this invention The sailing property control unit equipped with the control module which opts for the output about the control input of the equipment which affects said sailing property based on predetermined input in the vessel equipped with the equipment which affects a sailing property is formed. It is characterized by preparing the optimization processing section which is the real time and optimizes said control module by making the property as a vessel applicable to evaluation at said sailing property control device.
[0005]
[Embodiment of the Invention] The gestalt of operation of the sailing property control unit concerning this invention is explained referring to some examples shown in the accompanying drawing hereafter. Drawing 1 is the outline block diagram showing one example of the sailing control device concerning this invention. As shown in a drawing, this sailing control unit made suitable external world information input, based on that input, determined the information about the control input of the equipment which affects a sailing property, and is equipped with the control module to output. Preferably, although this control module may be the control module which has adopted the fuzzy inference system, for example, a fuzzy control machine, a fuzzy decision-making system, or a fuzzy neuro-controller, it is not limited to this. Moreover, this sailing control unit is equipped with the optimization processing section, and it has the interactive evolution processing section and/or the autonomous mold evolution processing section, and by these evolution processing sections, by making the property as a vessel applicable to evaluation, this optimization processing section is the real time, and optimizes the parameter of said control module. As long as the parameter which should be optimized is a parameter about a control module, the parameter of arbitration is sufficient as it, for example, when the fuzzy inference system is adopted, the standardization multiplier of the parameter for deciding the number, the configuration, the location, and breadth of a member cypripedium function, a fuzzy rule, or an I/O value etc. is mentioned. Moreover, it is carried out about the evaluation for optimization by the evaluation section by which the user was beforehand designed based on the predetermined valuation basis to a direct deed and the autonomous mold evaluation processing section to the interactive evolution processing section. Thus, it becomes possible to fit the property of a vessel to a user's liking and operating environment in the real time with constituting from the real time by making the property as a vessel applicable to evaluation, so that the operating characteristic of the equipment which affects a sailing property can be optimized.
[0006] Next, the example which specified the controlled system for the example of application of the sailing property control unit concerning this invention is given and explained. Drawing 2 - drawing 17 show the example which applied the optimization approach concerning this invention to the outboard motor and trimming gear of a planing boat. Drawing 2 is the schematic diagram showing the relation between an outboard motor and a trimming gear, and a control unit. When liking of the navigation in favorite temporal response, for example, spring, and autumn of the user same [not to mention] when the control unit is shown, and this control unit 10 acquires the optimal navigation property and the acceleration property of realizing change, the fixed-speed air-mail control according to disturbance, and the acceleration optimum control of a flying-boat hull and liking of a user, i.e., a user, differs changes, even if the inside of drawing and a sign 10 respond, they are constituted so that the optimal navigation property and an acceleration property may acquire. In addition, in this example, a "navigation property" means the thing of the vessel speed control characteristic by electronic throttle-valve actuation and the trim adjustment. By inputting information, such as an engine speed, a rate, acceleration, a steering include angle, and throttle opening, and operating an electronic

throttle valve and the trimming gear equipped with the oil hydraulic cylinder and the hydraulic pump based on these input, a control device 10 controls the posture of an inhalation air content and a hull, and performs fixed-speed sailing control and an acceleration optimum control.
[0007] Drawing 3 and drawing 4 are the outline block diagrams showing the internal configuration of a control device 10. As shown in a drawing, this control unit 10 has a fixed-speed sailing control section and an acceleration optimization control section. A fixed-speed sailing control section has the navigation fuzzy control module which determines the opening of an electronic throttle valve, and whenever [angle-of-trim] based on predetermined input, the autonomous mold evolution processing section which optimizes the standardization multiplier of said navigation fuzzy control module, the navigation nature evaluation section which performs evaluation of the autonomous mold evolution processing section, and the interactive evolution section which optimizes the fuzzy rule of said navigation fuzzy control module, as shown in drawing 3 . Moreover, an acceleration optimization control section has the trim control module which determines whenever [angle-of-trim] based on predetermined input, the autonomous mold evolution processing section which optimizes the control parameter of said trim control module, the acceleration nature evaluation section which performs evaluation of the autonomous mold evolution processing section, and the interactive evolution processing section which optimizes the control parameter of said trim control module, as shown in drawing 4 . In addition, the above "a standardization multiplier" means the multiplier which adjusts the magnitude of I/O information.
[0008] 1. Control in a fixed-speed sailing control section : as a fuzzy inference system, for example, the simple reasoning method is used for a navigation fuzzy control module, and it outputs [whenever / electronic throttle valve-opening / to an engine speed, a rate, acceleration, and a steering include angle] variation whenever [variation and angle-of-trim]. Said fuzzy rule table may be designed based on an expert's navigation knowledge, and the fuzzy rule in the simple reasoning method is expressed with a real number value. The genetic algorithm is used for the autonomous mold evolution processing section in a fixed-speed sailing control section, as shown in drawing 5 , it codes the standardization multiplier of said navigation fuzzy control module, generates an individual, and it optimizes these standardization multipliers using a genetic algorithm. The navigation property that evaluation of the each object under autonomous mold evolution processing serves as a target For example, it is constituted so that the evaluation section set up so that the deflection of whenever [to the rate which the user defined / real velocity] approached below desired value and an evaluation value might become high may carry out. Consequently, the standardization multiplier of a navigation fuzzy control module is automatically optimized towards the navigation property used as a target, and when an operating environment and a flying-boat hull change, the optimal navigation property comes to be acquired. Thus, the evaluation section designed beforehand performs evaluation in evolution processing, and autonomous mold evaluation is called for the approach of enabling it to optimize automatically on these specifications. Moreover, the genetic algorithm is used for the interactive evolution processing section in a navigation control section, as shown in drawing 6 , it codes some fuzzy rule tables of said navigation fuzzy control module, generates an individual, and it optimizes some of these fuzzy rule tables using a genetic algorithm. It is constituted so that a user may perform evaluation of the each object under interactive optimization processing based on the actually felt degree of comfort, consequently some fuzzy rule tables of a navigation fuzzy control module are optimized according to evaluation of a user, and the optimal navigation property suitable for evaluation of a user comes to be acquired. Thus, how a user performs evaluation in evolution processing is called interactive evaluation on these specifications. Next, the evolution processing in the above-mentioned fixed-speed sailing control section is explained. Drawing 7 is a flow chart which shows the flow of evolution processing of a fixed-speed sailing control section. As mentioned above, in this control unit, in case evolution processing is performed, autonomous mold evaluation is performed about the autonomous mold evolution processing section of a fixed-speed sailing control section, and interactive evaluation is used about the interactive evolution processing section. Since the flow of optimization processing differs when the evaluation approaches differ, the following explanation divides and explains the evolution processing which adopted the autonomous mold evaluation approach, and the evolution processing which adopted the interactive evaluation approach.
a. As shown in evolution processing drawing 7 in the autonomous mold evolution processing section, determine at random within limits which determined the initial value of a standardization multiplier beforehand first, and generate the 1st generation which consists of two or more initial individuals (step 1-1). And fixed-speed sailing control evaluation to all the individuals of the 1st generation is performed (step 1-2). Here, if fixed-speed sailing control

evaluation is explained briefly, two or more individuals are operated in parallel in false by time sharing, and the evaluation value in the sum total of the period is compared. evaluation is changed according to the use region of an engine speed, for example, as shown at drawing 8 in the case of the troll using an engine low rotation region, about ten individuals, it controls every [1] and the absolute value of the difference of whenever [to a target rate / real velocity] is totaled for every sampling time, and specifically, the total indicator within 20 cycle repeat and an evaluation period is computed as an evaluation value by making this into 1 cycle. Since the effect by disturbance, such as the weather and a hydrographic condition (specifically for example, a wind and a wave), is arranged as total with an each object, carrying out like this can estimate the property of an each object impartially. In the case of the cruise using an engine high rotation region, to the above mentioned evaluation approach moreover, in order to control the unstable behavior generated at the time of a high speed, i.e., pitching to which a flying-boat hull shakes up and down, and the Dutch roll shaken at right and left, [in addition,] When pitching or the Dutch roll is detected, 0 is given as an evaluation value of an individual, a flying-boat hull is stabilized by decreasing an angle of trim to the include angle which pitching or the Dutch roll does not generate, and an each object is henceforth evaluated by making the include angle into the maximum angle of trim. By carrying out like this, it can prevent that unstable behavior occurs at the time of a high speed. Based on the evaluation value of the each object acquired by the above-mentioned evaluation value computation (step 1-2), it evaluates whether it is the optimal navigation property (step 1-3), and judges whether the optimal navigation property has been acquired as a result of evaluation (step 1-4). And when the optimal navigation property is acquired, evolution processing is ended, when not obtained, it goes into an evolution mold count module, and a next-generation population is generated (step 1-5).
b. As shown in evolution processing drawing 7 in the interactive evolution processing section, there are usually the control mode and evolution mode in the interactive evolution processing section. Usually, a switch (step 2-1) in the control mode and evolution mode may be performed based on a user's volition through an interface as performed based on the conditions decided beforehand, for example, time amount, and shown in drawing 9 . Usually, in the control mode, fuzzy control is performed using the fuzzy rule table decided at the time, and it asks for the accumulating totals of the goodness of fit of each fuzzy rule until it changes to evolution mode at coincidence (step 2-2). It ends, when it adds to the accumulating-totals table which calculates the accumulating totals of a goodness of fit until it changes the result of an operation of a goodness of fit table which calculates the goodness of fit of each fuzzy rule in a certain time of day to evolution mode (step 2-3) and this is specifically changed to evolution mode, as shown in drawing 10 . If it changes to evolution mode, a number of arbitration of fuzzy rules which correspond to drawing 7 with reference to an accumulating-totals table so that it may be shown will be coded for a chromosome sequentially from the large thing of accumulating totals (step 2-4), the perturbation which followed normal distribution by making this into initial value will be added, and the 1st generation which consists of two or more initial individuals will be generated (step 2-5). And it test-rides using the parameter of one individual of the 1st generation (step 2-6), and a user inputs the evaluation value over the individual (step 2-7). When it judges whether the favorite navigation property was acquired (step 2-8) and it is judged based on said evaluation value that it was obtained, evolution processing is ended by making the individual into the maximum superior individual, and when not obtained, a trial ride and evaluation judge whether it is the termination method no to all the individuals of one generation (step 2-9). When all individuals and evaluations are not completed, the fuzzy rule of a fuzzy control module is changed into the thing of another individual (step 2-10), and it is made to test-ride again (step 2-6). moreover, when the trial ride and evaluation to all individuals are completed When it judges whether the convention generation number was reached (step 2-11) and it is judged that it reached In the generation, by making an individual with the highest evaluation value into the maximum superior individual, when it ends and it is judged that evolution processing has not reached, it goes into an evolution mold count module (step 2-12), and a next-generation individual county is generated, and the trial ride and evaluation using a fuzzy rule of those individuals are performed again. The above processing is repeatedly performed until a favorite navigation property is acquired or it reaches a convention generation number, consequently some fuzzy rule tables of a navigation fuzzy control module are transposed to the fuzzy rule of the obtained individual, and an accumulating-totals table is initialized by 0 (step 2-13). Then, it asks for the accumulating totals of the goodness of fit of each fuzzy rule at this time until it will perform fuzzy control using the replaced fuzzy rule table and will change to evolution mode again, if it usually changes to the control mode. By repeating the above-mentioned processing, the accumulating totals of a goodness of fit are high. In order not to change the fuzzy rule of the field which becomes possible [optimizing intensively about the fuzzy rule of the field which may set by the current environment and is used], and is seldom used, An environment changes suddenly, and

even when the fuzzy rule of the field currently seldom used is used, it becomes possible to perform stable control. [0009] 2. The control trim control module in an acceleration optimization control section outputs the trim variation to a rate. Drawing 11 is a graph which shows the relation between the rate-system head curve of a vessel, and a trim location. As shown in drawing 11 , the rate-system head curve of a vessel changes greatly with trim locations. The resistance generated between a flying-boat hull and the water surface can roughly be divided into wave making resistance and frictional resistance. Wave making resistance is resistance by the wave which oneself generates at the time of promotion of a vessel, and frictional resistance is resistance generated by friction with a flying-boat hull and the water surface. In a low-speed area, wave making resistance increases as it accelerates, and in a certain rate, it becomes a limit. This condition is called a hump, and a hump becomes large gradually as it is the smallest and approaches the full trim out whose angle of trim is in the biggest condition, when it is the full trim in which is in the condition that an angle of trim is the smallest." If a hump is exceeded, wave making resistance becomes small gradually and will be in a play NINGU condition soon. The frictional resistance at the time of play NINGU is the largest at the time of full trim in, and becomes the smallest near full trim out at it. Usually, when accelerating from the time of a stop to full speed manually, a throttle is made full open from the condition of full trim in, and it is operated to an out side from the time of exceeding a hump to the angle of trim in which pitching and the Dutch roll do not generate a trim gradually. pressing down wave making resistance and frictional resistance by carrying out like this -- possible -- becoming -- as a result -- the time of a stop -- oh, time amount until it reaches full speed is shortened. However, the class of flying-boat hull changes greatly with disturbance, and an angle of trim final in the timing which operates a trim, and the rate list to operate requires an advanced actuation technique. The genetic algorithm is used for the autonomous mold evolution processing section in an acceleration optimization control section, as shown in drawing 12 , it codes the control parameter (whenever [trim out initial speed T1, trim actuation rate T2, and last angle-of-trim] T3) of a trim control module, generates an individual, and it optimizes these control parameters using a genetic algorithm. The acceleration property that evaluation of the each object under autonomous mold evolution processing serves as a target For example, so that time amount until it reaches the rate defined from the time of a stop is short It is constituted so that the evaluation section set up so that an evaluation value might become high may carry out, consequently the control parameter of a trim control module is automatically optimized towards the acceleration property used as a target, and when an operating environment and a flying-boat hull change, the optimal acceleration property comes to be acquired. Moreover, the genetic algorithm is used for the interactive evolution processing section in an acceleration optimization control section, and it codes the control parameter of a trim control module, generates an individual, and optimizes these control parameters using a genetic algorithm. It is constituted so that a user may perform evaluation of the each object under interactive optimization processing based on the actually felt degree of comfort, consequently the control parameter of a trim control module is optimized according to evaluation of a user, and the optimal acceleration property suitable for evaluation of a user comes to be acquired. The change of the autonomous mold evolution processing section and the interactive evolution processing section may be performed based on a user's intention through an interface as performed based on the conditions defined beforehand, for example, time amount, and shown in drawing 7 . Based on the optimal acceleration property which performed evolution processing in the autonomous mold evolution processing section first, and was specifically acquired there When an individual which performs evolution processing in the interactive evolution processing section, may constitute so that liking of a user may be suited and it may tune finely, and does not enter during autonomous mold evolution processing at a user's mind occurs, a user may give the evaluation value 0 on that spot, and you may constitute so that it may change to degree individual. Next, the evolution processing in the above-mentioned acceleration optimization control section is explained. Drawing 13 is a flow chart which shows the flow of evolution processing of an acceleration optimization control section.

a. As shown in evolution processing drawing 13 in the autonomous mold evolution processing section, determine at random in the range which was able to determine the initial value of a control parameter beforehand first, and generate the 1st certain generation from two or more initial individuals (step 1-1). And acceleration optimization control evaluation to all the individuals of the 1st generation is performed (step 1-2). Here, if acceleration optimization control evaluation is explained briefly, time amount until it accelerates at full throttle to the rate defined from the stop condition and reaches the defined rate once per one individual will be computed as an evaluation value. Based on the evaluation blood of the each object acquired by the above-mentioned evaluation value computation (step 1-2), it evaluates whether it is the optimal acceleration property (step 1-3), and judges whether the optimal acceleration property has been acquired as a result of evaluation (step 1-4). And when the optimal navigation property is acquired,

evolution processing is ended, when not obtained, it goes into an evolution mold count module, and a next-generation individual county is generated (step 1-5).
b. As shown in evolution processing drawing 13 in the interactive evolution processing section, determine at random in the range which was able to determine the initial value of a control parameter beforehand first, and generate the 1st generation which consists of two or more initial individuals (step 1-2). And it test-rides using the parameter of which [of the 1st generation] individual (step 2-2), and a user inputs the evaluation value over the individual (step 2-3). When it judges whether the favorite acceleration property was acquired (step 2-4) and it is judged based on said evaluation value that it was obtained, evolution processing is ended, and when not obtained, it judges whether a trial ride and evaluation were completed to all the individuals of one generation (step 2-5). When the trial ride and evaluation to all individuals are not completed, the parameter of a trim control module is changed into the thing of another individual (step 2-6), and it is made to test-ride again (step 2-2). Moreover, when the trial ride and evaluation to all individuals are completed, it goes into an evolution mold count module (step 2-7), and a next-generation individual county is generated, again, it swerves and the trial ride and evaluation using a parameter of that individual are performed. These processings are repeatedly performed until a favorite acceleration property is acquired, consequently the parameter of a trim control module is optimized. Here, if evaluation of the acceleration property which adopted the interactive mode is explained, once per one individual, it will accelerate at full throttle to the rate defined from the stop condition, and an evaluation value will be inputted based on the feeling of acceleration and degree of comfort which the user felt.
[0010] Here, some examples of an evolution mold count module are explained.
a. Genetic algorithm (GA)
Drawing 14 is the outline flowchart of the evolution mold count module at the time of using a genetic algorithm as evolution mold calculus. By this module, after the termination of evaluation of all individuals of one generation, when a favorite property is acquired and it swarms, a next-generation individual county is generated. About a scaling (step 1), linear transformation of fitness is performed so that the ratio of the maximum fitness in an individual county and average fitness may become fixed. About selection (step 2), the roulette selection method chosen probable in proportion to a user's evaluation value (fitness) may be adopted. Moreover, the tournament selection which chooses a thing with the best evaluation value in n individuals chosen at random can also be used. There is technique, such as one-point decussation, two-point decussation, or normal-distribution decussation, in decussation (step 3). In addition, although that the parents chosen for decussation are the same individuals can also start, since the versatility as an individual county will be lost when this is left, when the parents chosen as decussation are the same individuals, it changes for the individual as which others were chosen, and decussation of the same possible individual is avoided. About mutation (step 4), it is a probability fixed about each locus of an individual, and a value is changed at random. The method of adding the perturbation which follows normal distribution in addition to this is also considered. In spite of having chosen a different individual as parents of decussation, mutation is produced in a probability higher than usual about both parents whom it sees hereditarily, and they intersect in being completely the same. Moreover, the technique of the alternation of generations called "playback" which replaces all the individuals of time cost other than the above at once may be used. Furthermore, since there is a possibility of destroying the high individual of evaluation when an alternation of generations is applied strictly, the elite preservation strategy of leaving the elite (a number of arbitration of individuals which gained high evaluation) unconditionally to the next generation may be doubled and used.
b. Evolution strategy (ES)
Drawing 15 is the outline flowchart of the evolution mold count module at the time of using an evolution strategy as evolution mold calculus. By this module, after the termination of evaluation of all individuals of one generation, when a favorite property is not acquired, a next-generation individual county is generated. Since the method of selection changes with classes of evolution strategy about selection (step 1), two kinds of typical technique is explained here. In the case of the evolution strategy called (mu, lambda)-ES, mu individual is definitely chosen sequentially from the good thing of fitness from the child individuals of lambda individual generated from the parent individual of mu individual. (Micro+lambda) In the case of the evolution strategy called -ES, mu individual is definitely chosen sequentially from the good thing of fitness from the individual counties with which the parent individual of mu individual and the child individual of lambda individual were doubled. There is the following technique other than the above in an evolution strategy, and in using these, it performs the method of the selection doubled with such technique.

- 1 1-ES : random walk (RW)
- 1+1-ES : hill climbing (HC)
- 1, lambda-ES, heuristics near (1+lambda)-ES: and (mu+1) -ES : although normal-distribution decussation is used about continuation generation mold multipoint heuristics decussation (step 2), it is good in inheriting parents' value for every parameter also considering the middle point, an internally dividing point, or an externally dividing point as a child's value. About mutation (step 3), the perturbation which follows normal distribution to each parameter is added. At this time, distribution of normal distribution may adjust for every parameter, and may give correlation between parameters. As explained above, since each parameter is used for an evolution strategy (ES) with a real number value, it has the advantage that the conversion to genotype from phenotype like a genetic algorithm becomes unnecessary. Moreover, parents' characteristic can be made to reflect strongly in a child's characteristic the binary code and Gray code which may set to a genetic algorithm and are used by using the decussation approach in consideration of the continuity of the real numbers, such as normal-distribution decussation, rather than one-point decussation or the thing which carries out multipoint decussation.

c. Evolutional programming (EP)

Drawing 16 is the outline flowchart of the evolution mold count module at the time of using evolutional programming as the evolution mold count technique. Let the number which won [individual / of 2micro individual which doubled the individual after adding an individual and a perturbation before adding a perturbation when a population was mu individual] about the scaling (step 1) as compared with q individuals chosen as random, respectively be the goodness of fit of the individual. Selection (step 2) chooses mu individual sequentially from the good thing of fitness from the generated individual counties. Although selection is deterministic, since the scaling is probable, selection becomes probable substantially. Evolutional programming (EP) explained above has the advantage that the change to genotype from phenotype like a genetic algorithm becomes unnecessary in order to use each parameter with a real number value. Moreover, since decussation is not used, there is no constraint in phenotype. ******, the tree structure, etc. are sufficient as the need that a genetic algorithm makes a parameter the shape of a string like an evolution strategy.

[0011] Since an operating environment is remarkably changed by change of the weather or a season and liking of a user is also changed remarkably, the planing boat explained by this example Since it is an impossible controlled system substantially to acquire the vessel speed control characteristic all users can be satisfied with the bottom of all operating environments of the control characteristic in the phase of a design or the phase of setting before shipment and an outboard motor and a hull are usually manufactured separately, Although it is very difficult to optimize the property of a fuzzy control machine according to all conditions when the throttle control and angle-of-trim control which were doubled with the hull are needed in addition to the property of an operating environment and a user and the fuzzy control machine is used for the control device in order to perform optimal vessel speed control By constituting so that the parameter of the navigation fuzzy control module of the control device 10 which controls electronic throttle-valve actuation and a trim adjustment can be optimized in the real time using evolution mold count, as explained above The remarkable effectiveness of becoming possible to perform vessel speed control suitable for all these conditions is done so.

[0012] By inputting information, such as an engine speed, a rate, acceleration, and a steering include angle, and operating an electronic throttle valve and a trimming gear in the example explained above, based on these input Fixed-speed sailing control is performed by controlling the posture of an inhalation air content and a flying-boat hull. A fixed-speed sailing control section Based on predetermined input, a navigation fuzzy control module determines the opening of an electronic throttle valve, and whenever [angle-of-trim]. The standardization multiplier of said navigation fuzzy control module is optimized using autonomous mold evaluation. By optimizing the fuzzy rule of said navigation fuzzy control module using interactive evaluation, and inputting a rate, and operating a trimming gear based on input Acceleration control is performed by controlling a posture. An acceleration optimization control section Although the sailing control unit which determined whenever [angle-of-trim] with the trim control module based on predetermined input, and optimized the control parameter of said trim control module using autonomous mold evaluation and interactive evaluation is explained A sailing control unit to this invention, without being limited in the above-mentioned example For example, you may constitute so that evaluation may be performed based on fuel consumption specific consumption and/or power consumption, and you may carry out based on a user's degree of comfort and an acceleration optimization control section may be equipped with an electronic throttle control module. Moreover, although it consists of above-mentioned examples so that it may optimize about the outboard motor and trimming gear

of a planing boat Without being limited to this example, as shown in drawing 17 , this, for example The engine and water nozzle trimming gear in personal water Kraft used as a combination finished product combining an engine and a water nozzle trimming gear, and a flying-boat hull are used as an unit. When this invention is applied, the property as personal water Kraft is optimized for the control unit which controls the electronic throttle valve gear and water nozzle trimming gear in an engine as a valuation basis. As it becomes possible to optimize control of the posture of an inhalation air content and a flying-boat hull and is shown in drawing 18 The outboard motor and trimming gear in the planing boat used as a combination finished product combining a flying-boat hull, and the outboard motor and trimming gear which carried the gasoline engine are used as an unit. It becomes possible to optimize the property of a planing boat for the control unit which controls the electronic throttle valve gear and trimming gear in an engine as a valuation basis, and to optimize control of the posture of an inhalation air content and a flying-boat hull, when this invention is applied. furthermore, as shown in drawing 19 , in offering this invention by using as an unit the outboard motor and flap mobile in the planing boat used as a combination finished product combining a flying-boat hull, and the outboard motor and flap mobile which carried the diesel power plant It becomes possible to optimize the property of a planing boat for the control unit which controls the fuel injection equipment and flap mobile in an engine as a valuation basis, and to optimize control of the posture of fuel oil consumption and a flying-boat hull.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the outline block diagram showing one example of the sailing property control device concerning this invention.
[Drawing 2] It is the schematic diagram showing the relation between an outboard motor and a trimming gear, and a control unit.
[Drawing 3] It is the outline block diagram showing the internal configuration of a control device 10.
[Drawing 4] It is the outline block diagram showing the internal configuration of a control device 10.
[Drawing 5] It is drawing showing notionally the relation between the standardization multiplier of a navigation fuzzy control module, and the individual which coded it and was generated.
[Drawing 6] It is drawing showing notionally the relation between the fuzzy rule table of a navigation fuzzy control module, and the individual which coded the part and was generated.
[Drawing 7] It is the flow chart which shows the flow of evolution processing of a fixed-speed sailing control section.
[Drawing 8] It is the graph which shows an example of the method of time sharing in case time sharing estimates two or more individuals.
[Drawing 9] Usually, it is drawing showing an example of an interface which performs a switch in the control mode and evolution mode.
[Drawing 10] It is drawing showing an example of how to ask for the accumulating totals of the goodness of fit of a fuzzy rule.
[Drawing 11] It is the graph which shows the relation between the rate-system head curve of a vessel, and a trim location.
[Drawing 12] It is drawing showing an example of the individual used in the autonomous mold evolution processing section in an acceleration optimization control section.
[Drawing 13] It is the flow chart which shows the flow of evolution processing of an acceleration optimization control section.
[Drawing 14] It is the outline flowchart of the evolution mold count module at the time of using a genetic algorithm as evolution mold calculus.
[Drawing 15] It is the outline flowchart of the evolution mold count module at the time of using an evolution strategy as evolution mold calculus.
[Drawing 16] It is the outline flowchart of the evolution mold count module at the time of using evolutional programming as the evolution mold count technique.
[Drawing 17] It is the schematic diagram showing another example of application of this invention.
[Drawing 18] It is the schematic diagram showing still more nearly another example of application of this invention.
[Drawing 19] It is the schematic diagram showing still more nearly another example of application of this invention.

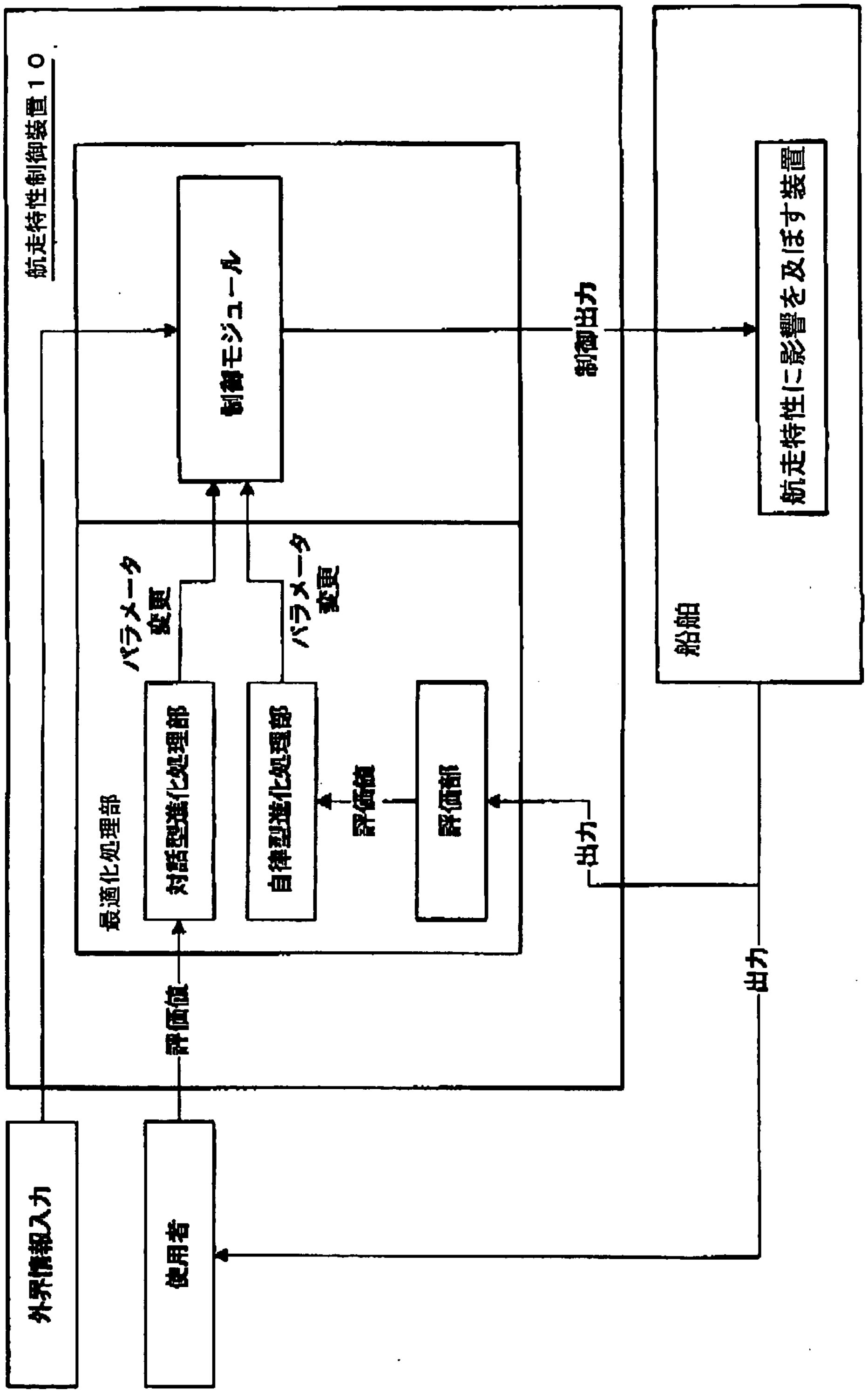
[Translation done.]

DRAWINGS

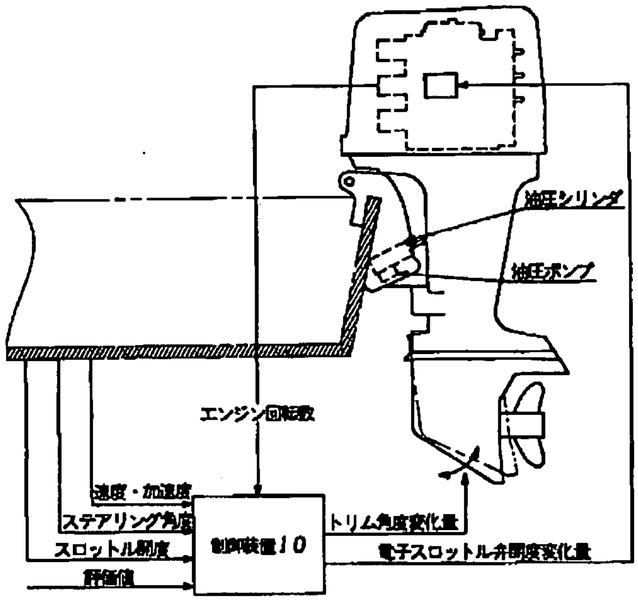
[Drawing 12]

T1	T2	T3

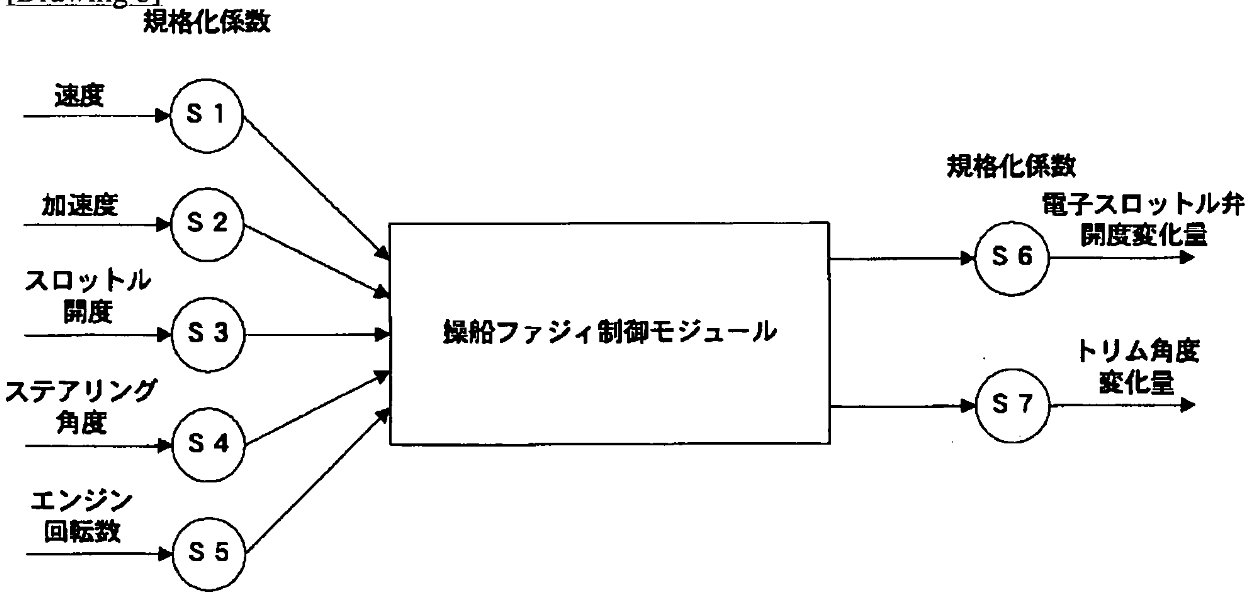
[Drawing 1]


航走特性制御装置１０
制御モジュール
制御出力
航走特性に影響を及ぼす装置
船舶
最適化処理部
対話型進化処理部
自律型進化処理部
評価部
パラメータ変更
パラメータ変更
評価値
評価値
出力
出力
外界情報入力
使用者

[Drawing 2]

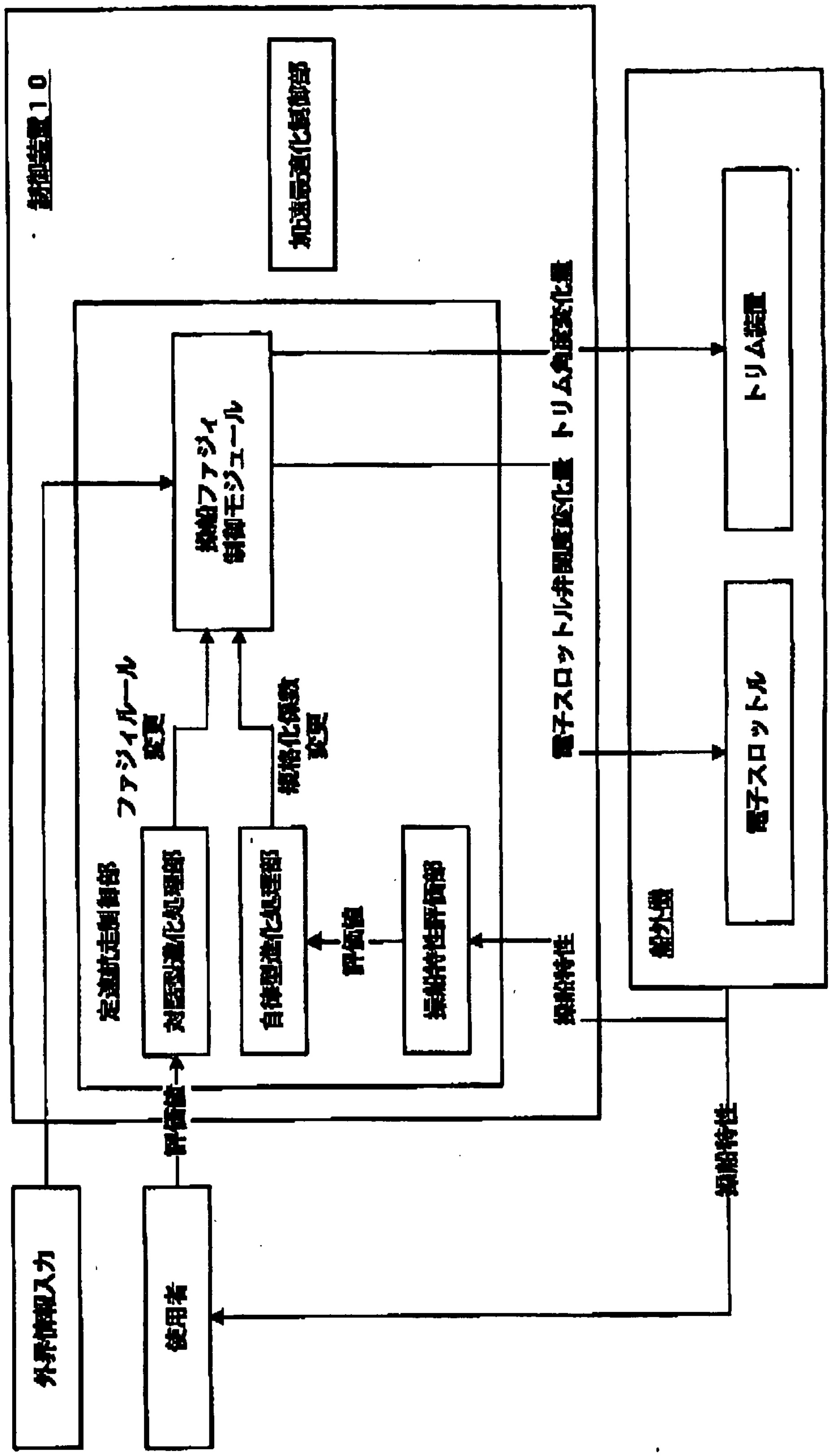


[Drawing 5]

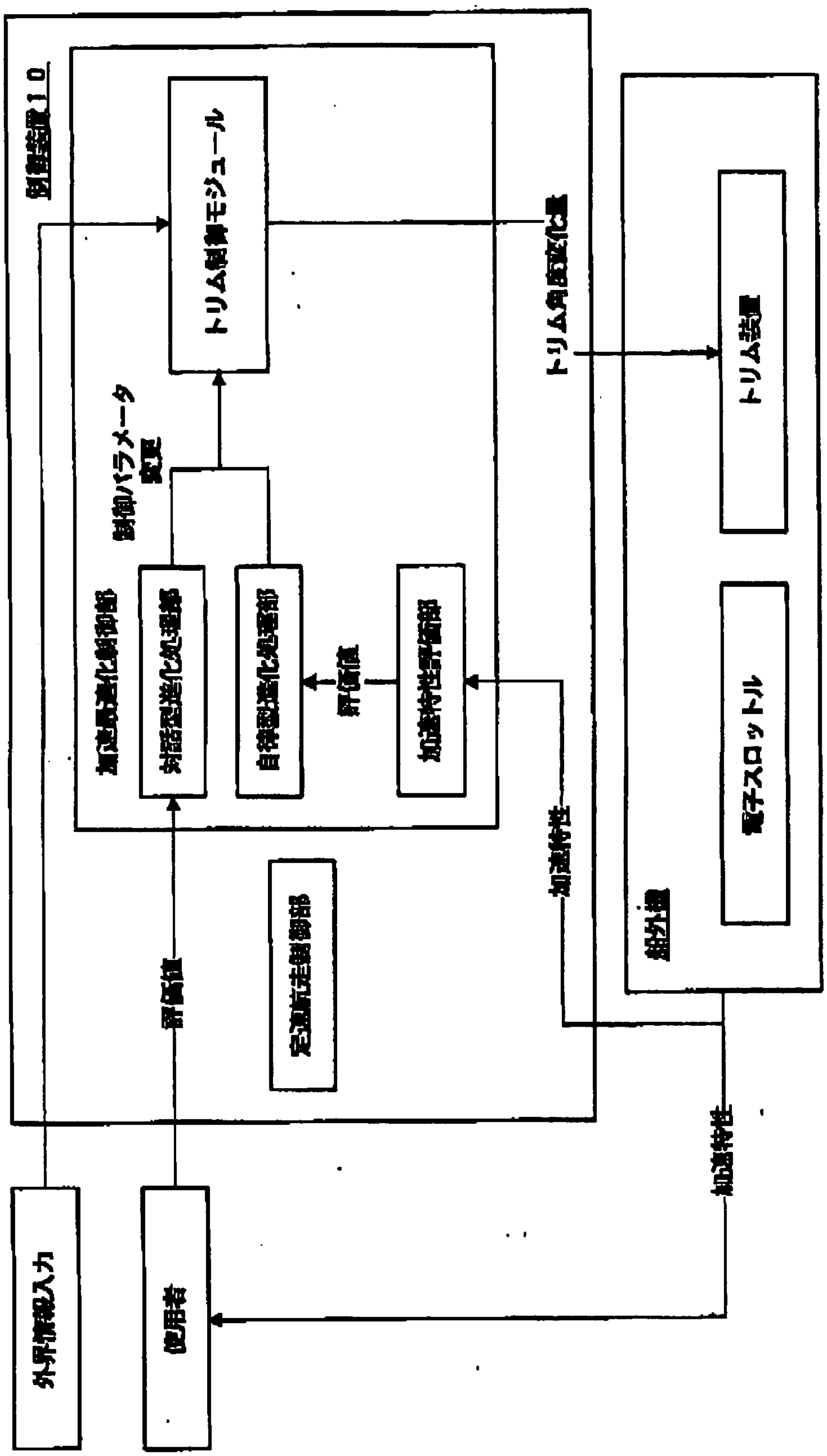


S 1	S 2	S 3	S 4	S 5	S 6	S 7

[Drawing 3]


制御装置１０
加速感適化制御部
定速航走制御部
操船ファジィ
制御モジュール
対話型適化処理部
自律型適化処理部
操船特性評価部
ファジィルール
変更
規格化係数
変更
評価値
操船特性
電子スロットル弁開度変化量
トリム角度変化量
トリム装置
電子スロットル
船外機
外界情報入力
使用者
評価値
操船特性

[Drawing 4]


制御装置10
トリム制御モジュール
制御パラメータ変更
加速度進化制御部
対話型進化処理部
自律型進化処理部
評価値
加速特性評価部
定速航走制御部
評価値
トリム角度変化量
トリム装置
電子スロットル
船外機
加速特性
加速特性
外界情報入力
使用者

[Drawing 6]

速度

加速度	FAST	MID	SLOW
PL	－10°	－5°	－1°
PS	－5°	－1°	0°
ZR	－1°	① 0°	③ ＋1°
NS	0°	② ＋1°	④ ＋5°
NL	＋1°	＋5°	＋10°

ファジィルールテーブル

入力：速度，加速度
出力：電子スロットル弁開度変化量

抽出 →

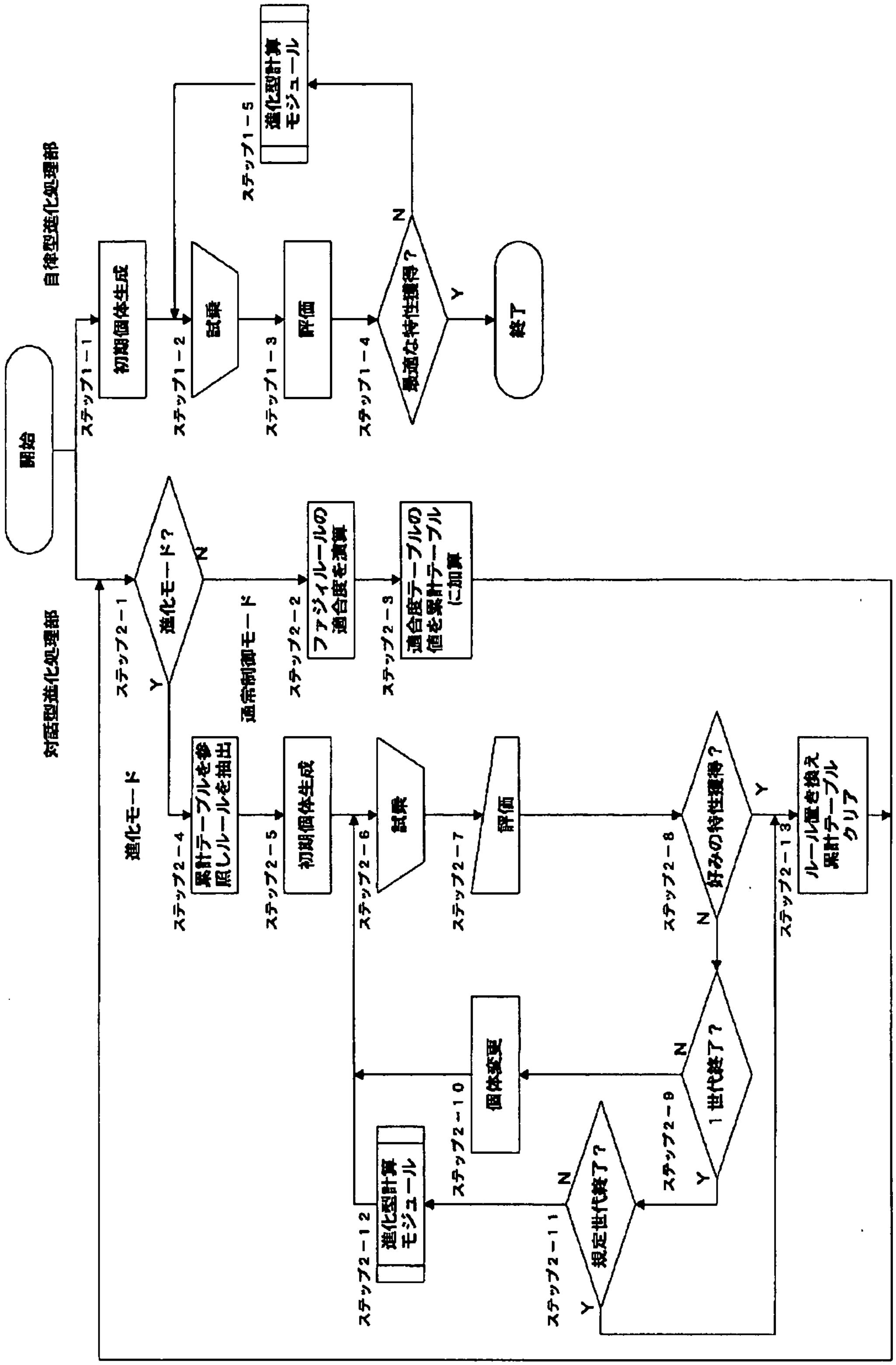
①	②	③	④
0°	＋1°	＋1°	＋5°

正規乱数を加えた摂動 →

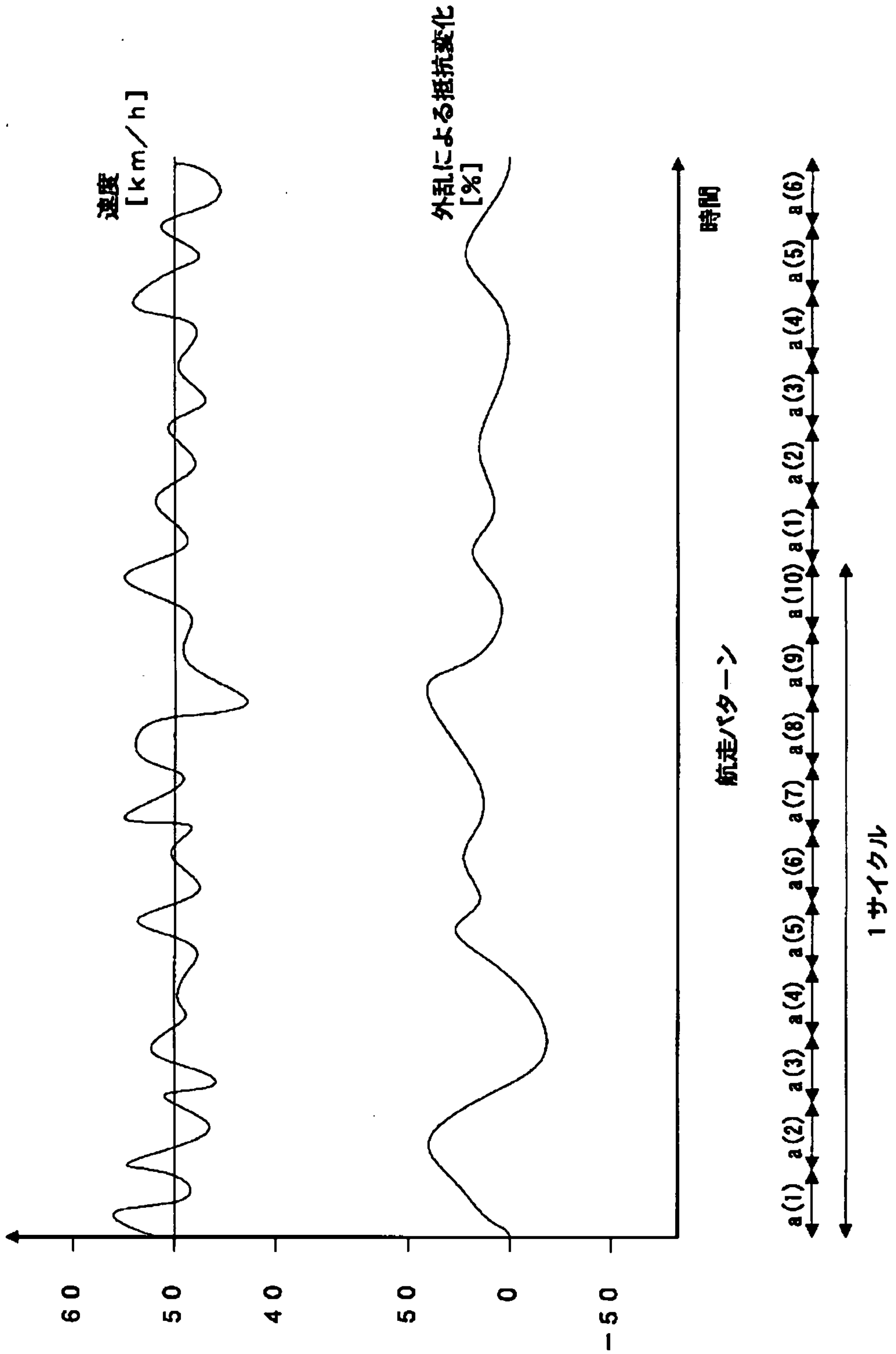
＋0．5°	＋1．3°	＋0．4°	＋6．1°
－0．3°	＋1．4°	＋2．0°	＋4．9°
＋0．9°	＋0．6°	＋1．5°	＋5．2°

● ● ●

[Drawing 7]

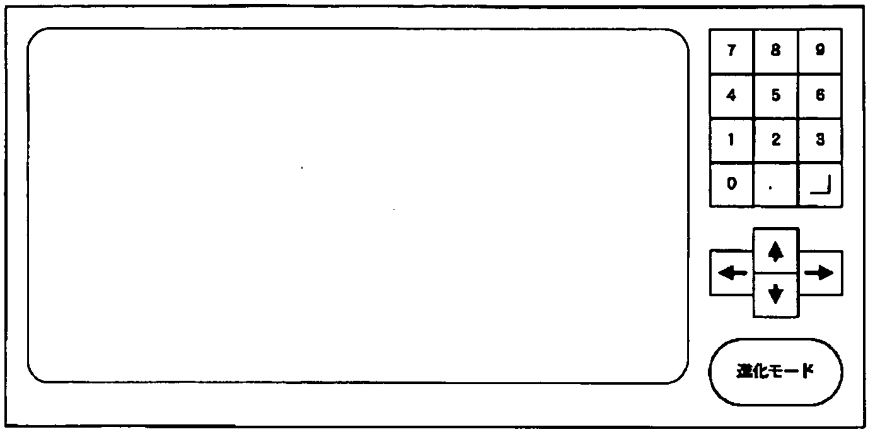

自律型進化処理部
開始
ステップ1−1
初期個体生成
ステップ1−2
試乗
ステップ1−3
評価
ステップ1−4
最適な特性獲得？
Y
N
終了
ステップ1−5
進化型計算モジュール
対話型進化処理部
ステップ2−1
進化モード？
Y
N
通常制御モード
ステップ2−2
ファジィルールの適合度を演算
ステップ2−3
適合度テーブルの値を累計テーブルに加算
進化モード
ステップ2−4
累計テーブルを参照しルールを抽出
ステップ2−5
初期個体生成
ステップ2−6
試乗
ステップ2−7
評価
ステップ2−8
好みの特性獲得？
Y
N
ステップ2−9
1世代終了？
Y
N
ステップ2−10
個体変更
ステップ2−11
規定世代終了？
Y
N
ステップ2−12
進化型計算モジュール
ステップ2−13
ルール置き換え累計テーブルクリア

[Drawing 8]

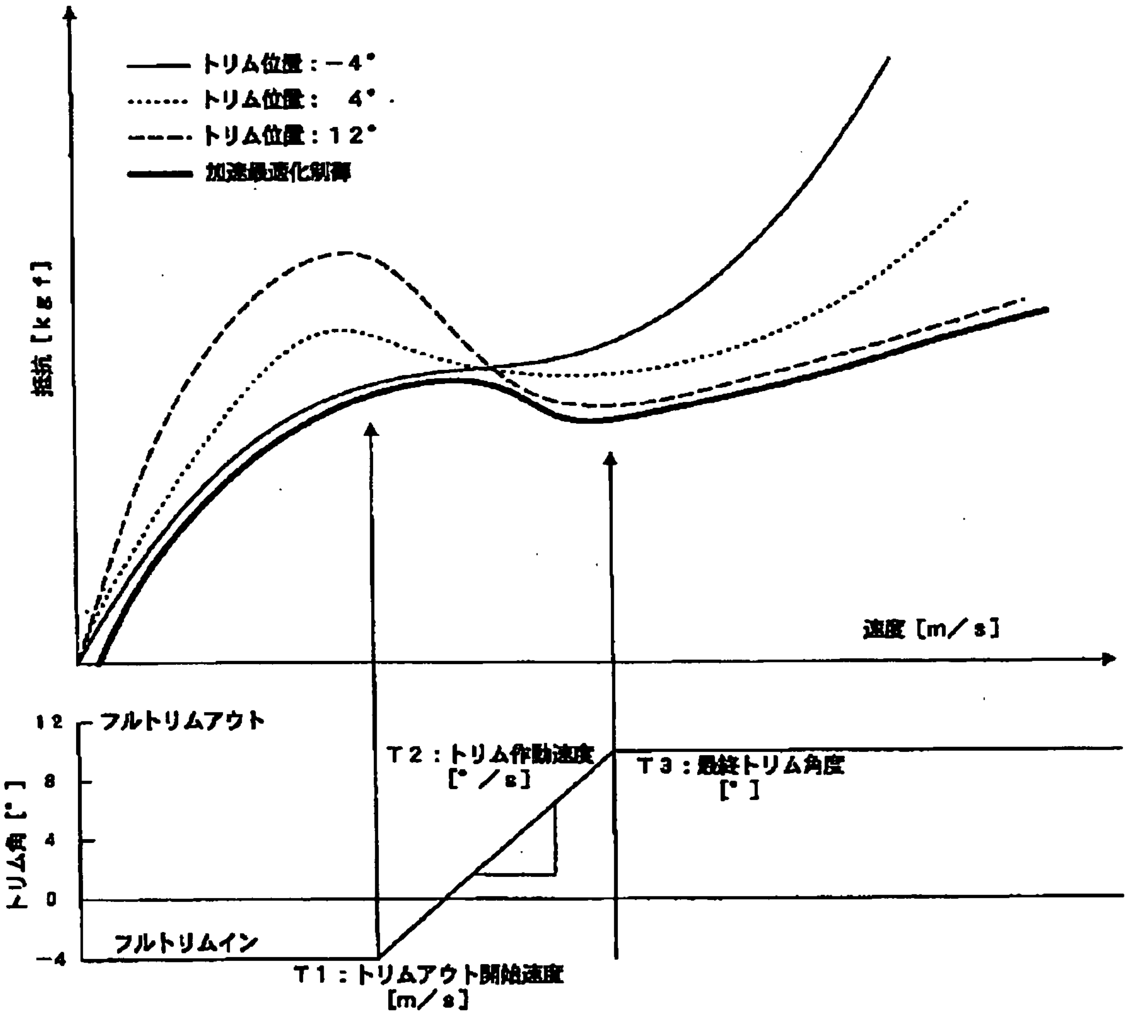


速度
[km/h]
外乱による抵抗変化
[%]
時間
航走パターン
1サイクル
60
50
40
50
0
−50
a(1) a(2) a(3) a(4) a(5) a(6) a(7) a(8) a(9) a(10) a(1) a(2) a(3) a(4) a(5) a(6)

[Drawing 9]



[Drawing 11]



[Drawing 10]

速度

加速度

	FAST	MID	SLOW
PL			
PS		0. 42	0. 28
ZR		0. 18	0. 12
NS			
NL			

適合度テーブル

加算 →

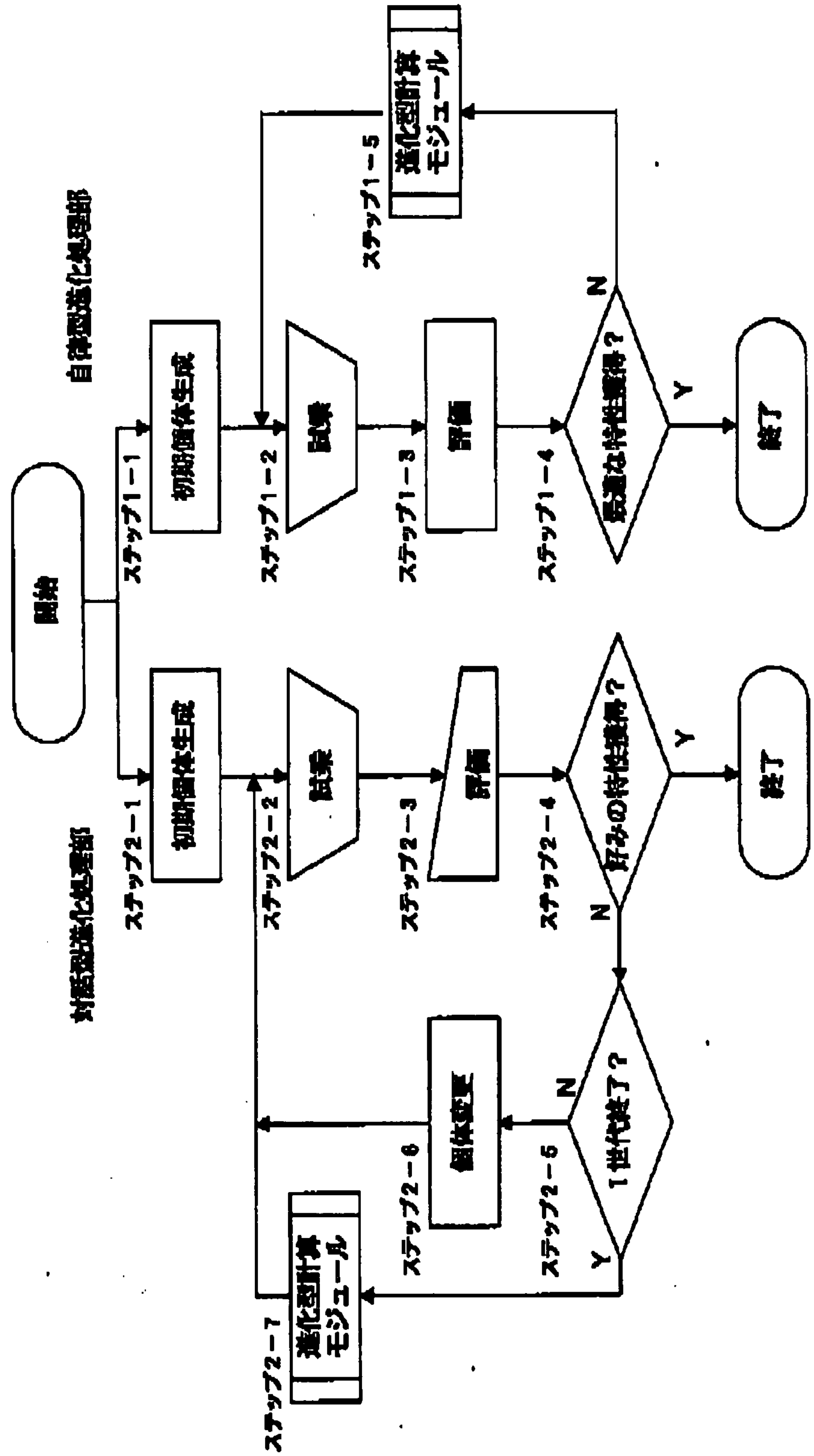
速度

加速度

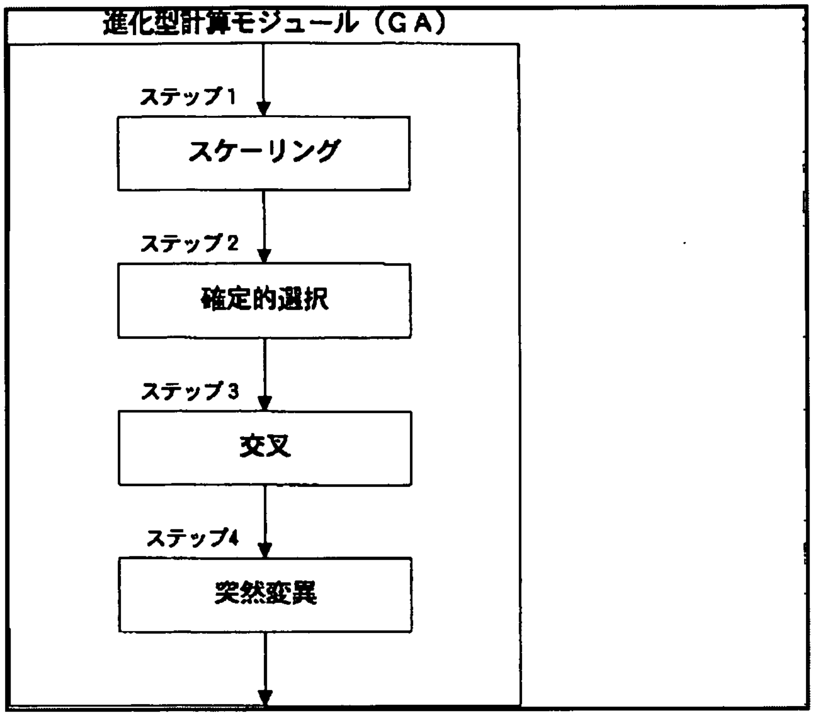
	FAST	MID	SLOW
PL	0. 02	1. 87	0. 27
PS	4. 96	8. 39	3. 72
ZR	12. 61	① 86. 42	③ 35. 48
NS	9. 55	② 49. 75	④ 22. 37
NL	8. 96	18. 19	2. 44

累計テーブル

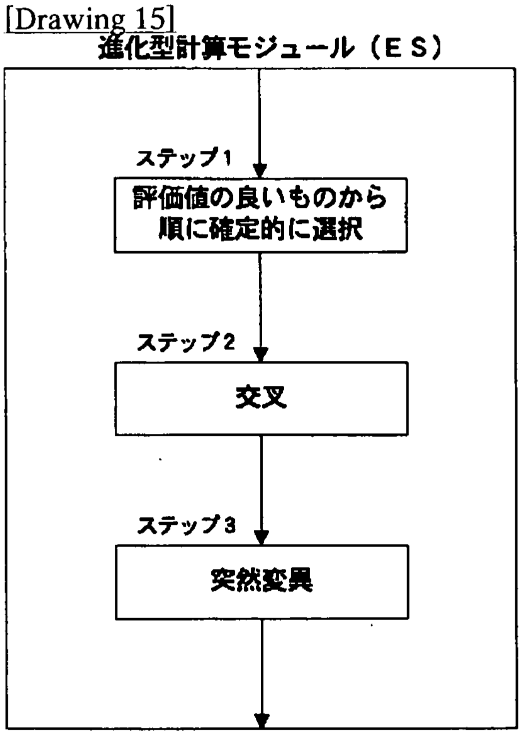
[Drawing 13]


自律型進化処理部
対話型進化処理部
開始
ステップ1－1
初期個体生成
ステップ1－2
試乗
ステップ1－3
評価
ステップ1－4
最適な特性獲得？
Y
N
終了
ステップ1－5
進化型計算モジュール
ステップ2－1
初期個体生成
ステップ2－2
試乗
ステップ2－3
評価
ステップ2－4
好みの特性獲得？
Y
N
終了
ステップ2－5
1世代終了？
Y
N
ステップ2－6
個体変更
ステップ2－7
進化型計算モジュール

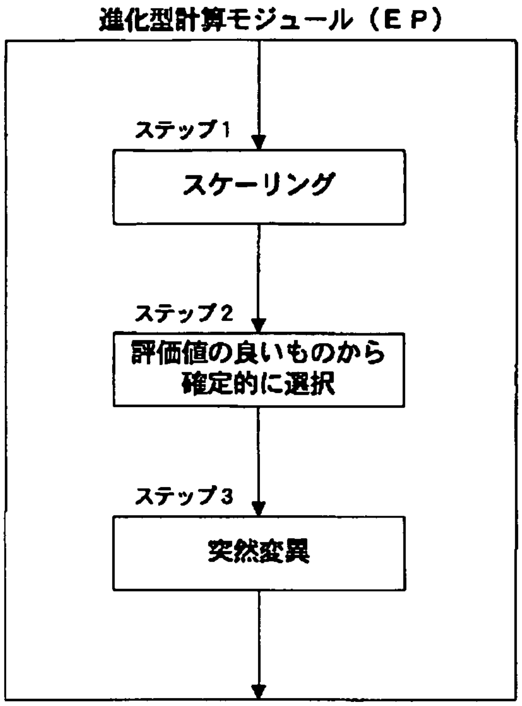
[Drawing 14 </A>]



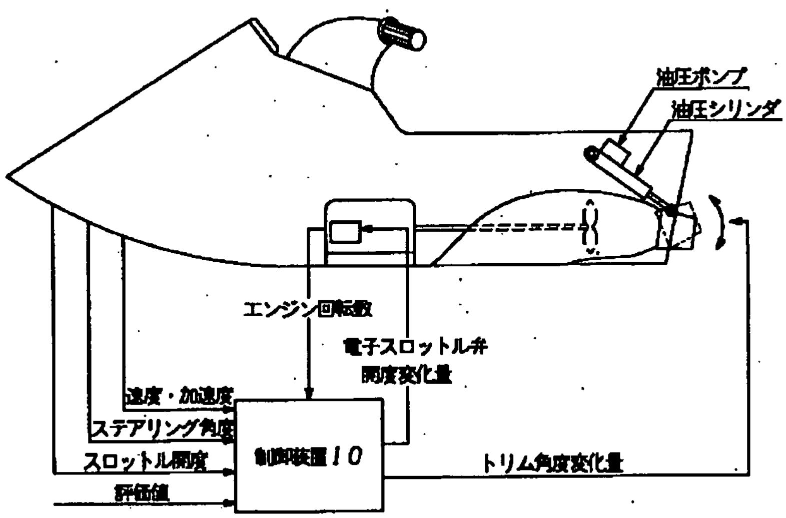
[Drawing 15]



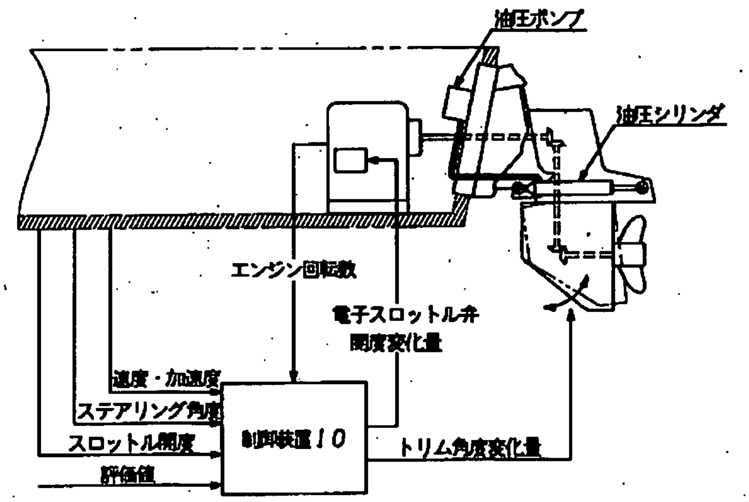
[Drawing 16]



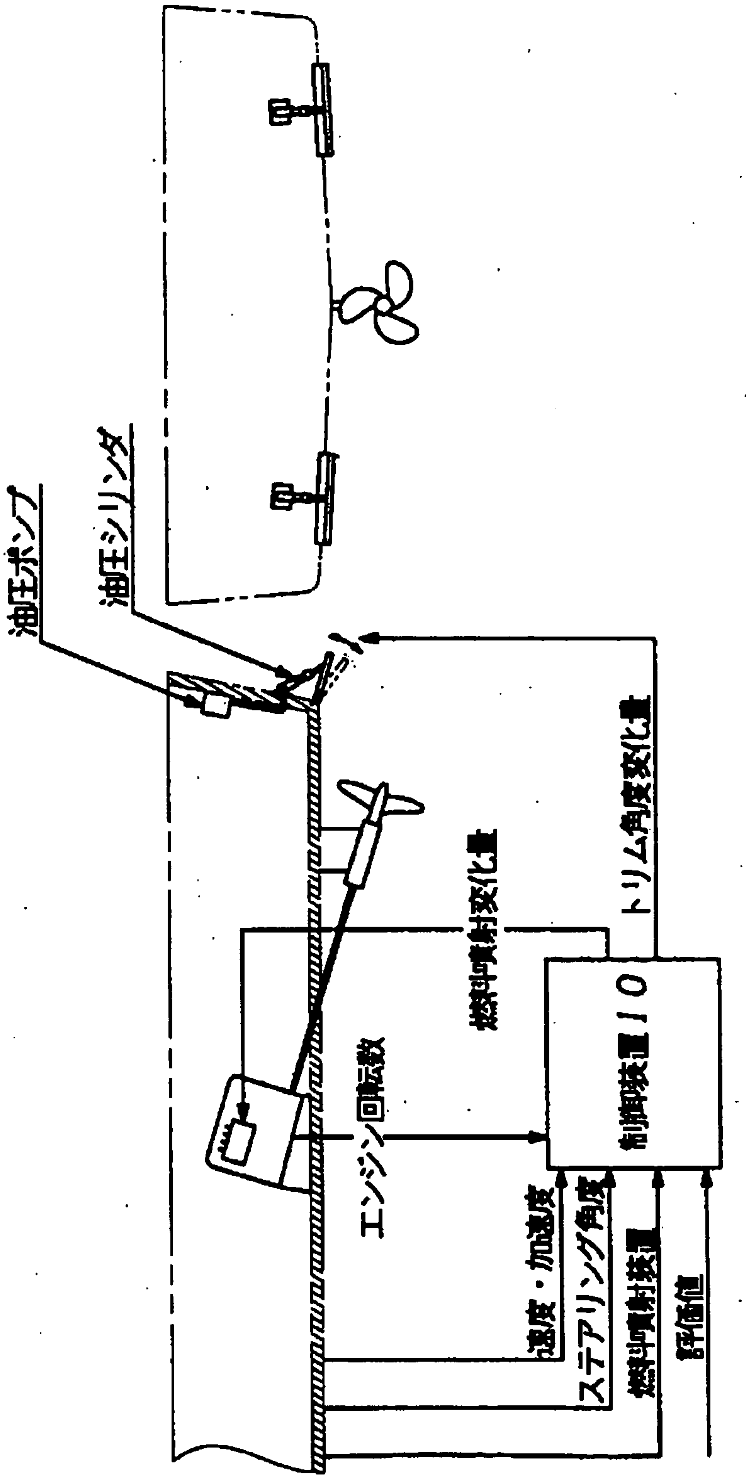
[Drawing 17]



[Drawing 18]


油圧ポンプ
油圧シリンダ
エンジン回転数
電子スロットル弁
開度変化量
速度・加速度
ステアリング角度
スロットル開度
評価値
制御装置10
トリム角度変化量

[Drawing 19]



[Translation done.]